FORECASTING PERSON TRIP ATTRACTIONS TO OUTDOOR RECREATION AREAS

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TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF TABLES

LIST OF FIGURES

SUMMARY

The explosion of the number of automobiles on today's highways has created many problems which have shown the necessity for efficient transportation planning. The magnitude of these problems is evidenced in the growing traffic congestion in urban areas. However, it is becoming increasingly evident that transportation planning should not be limited to urban areas but should be expanded to include transportation planning on a regional and statewide scale.

When considering transportation on a regional or statewide basis, recreation trips constitute the largest percentage of the total trips. Surveys have indicated that this percentage might be greater than 50 per cent. Therefore, it is of great importance to the transportation planner to be able to predict recreational trips and their patterns.

In recent years multiple linear regression techniques have been increasingly used to develop models for forecasting trip productions and attractions. The present study utilizes multiple linear regression techniques to develop models which will aid the transportation planner in forecasting person trip attractions to outdoor recreation areas.

In this study a total of 15 outdoor recreation areas were studied. Regression models were developed relating person trip attractions at these recreation areas to the socio-economic characteristics of the population surrounding these areas; the recreational facilities provided at these areas; and a combination of the socio-economic characteristics and the recreational facilities.

The results of this study indicated that person trip attractions to outdoor recreation areas are most closely related statistically to the recreational facilities provided at the recreation area. This research further indicated statistically that overnight housing facilities are the most important factor in determining attractions to recreation areas.

Although socio-economic characteristics play a predominant role in determining participation in outdoor recreation, this study indicated that these factors had little statistical influence on trip attractions to outdoor recreation areas. It was concluded that the primary reason is that outdoor recreation areas are not isolated, and the mobility provided by the automobile enables persons to chose from a number of recreation areas depending on the recreational facilities provided at the area.

CHAPTER I

INTRODUCTION

Today millions of Americans are spending increasingly more of their time and money on outdoor recreation than at any time in the past. The resulting increase in the volume of outdoor recreation is primarily due to increasing population, an increase in the average income, more leisure time, and the unequaled mobility that has come to the American people via the automobile and modern highways. To the transportation engineer and planner the implications of this change are far-reaching. It means that in the not too distant future that there must be an emphasis placed on planning on a regional and state wide basis equaling the present emphasis on the urban portion of the transportation problem.

In recent years much has been done to develop mathematical models to aid the transportation planner in predicting the number of trips that will be generated by a given type of land use. This approach has resulted in a detailed examination of trips by trip purpose because it was evident that different trip purposes had varying characteristics (1)*.

These methods and models were developed principally for urban areas, therefore they must be re-examined and evaluated to determine if they can be applied to the problem of regional and state wide planning.

Many urban transportation studies have shown that urban recreation trips account for only a small portion of the total trips, usually between

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* Figures in parentheses denote bibliographical references listed at the end of this thesis.

five and 15 per cent, while the work trip accounts for the largest portion of the total trips. On the other hand, the recreation trips constitute the largest portion of the total trips on a state wide basis. This fact was vividly pointed out by the statistics in a national travel survey conducted by the Bureau of the Census in 1963 (2). In this survey 61 per cent of all the trips were made for the purpose of visiting friends and relatives or pleasure. Thus, this percentage includes social trips as well as all other types of recreation trips.

This, of course, for the transportation planner means that the accuracy with which he can predict total trips on a state basis is to a large extent dependent on his ability to predict recreation trips.

At the present time little work has been done in the field of transportation planning to predict recreation trips outside large metropolitan areas. Since outdoor recreation areas attract large volumes of recreation trips, they are of particular concern to the transportation planner. Charles C. Cervo, in a study by the Connecticut Highway Department, has done some preliminary work in this field (3). However, this study had two main shortcomings which leave the results open to question. First, the equations that were developed by this study to predict the number of trips generated were based on only five recreation areas. Second, there was no information given as to how well the developed models were able to predict the trips generated by these areas.

A systems approach was used in a Michigan study to predict the trips generated to recreation areas (4). This approach is described in more detail in Chapter 3. The method yielded good results, but it is handicapped by the considerable volumes of data that are required as input information. Also, the procedure for reducing the data becomes extremely involved and makes the method undesirable from the standpoint of time and money.

The intent of the present study was to determine the socio-economic factors and recreation areas characteristics that influence the attraction of trips to outdoor recreation areas, and by using these factors to develop a multiple regression equation to serve as a model in predicting the total number of trips attracted to the recreation areas.

CHAPTER II

OUTDOOR RECREATION

Definition

Outdoor recreation is a vague and general term that encompasses a wide variety of activities. A good general definition was given in the report Kansas Recreation - Past, Present and Future: "Outdoor recreation . . . is any activity performed for enjoyment or pleasure in leisure time out of doors and in some way involving utilization of land and/or water resources." (5)

As this definition implies there is a wide range of activities that come under the general heading of outdoor recreation. Thus it becomes imperative that a person who is writing about outdoor recreation trips outline in clear and concise terms exactly his definition of outdoor recreation.

This study was concerned only with trips to developed outdoor recreation areas. Therefore, outdoor recreation, as defined in this study, includes all water related activities, hunting, nature or bird walks, picnicking, camping, horseback riding, playground activities, and playing golf.

In terms of this study a developed recreation area is one that has the minimum facilities of a lake and picnic areas, but may have any combination of the named activies. The requirement that there be a lake was chosen because of the important role that water plays in outdoor recreation. The importance of water in outdoor recreation has been pointed out by V. E. Montgomery: "Of all forms of outdoor recreation, water offers the greatest appeal. Many people are instinctively drawn to water, if only to drive where it is and look at it while resting and relaxing." (6)

Present and Future Outdoor Recreation Participation

Outdoor recreation is an activity that has widespread interest among the American people. It is not limited to any one group or area of the country. In one survey about 90 per cent of the persons surveyed took part in some form of outdoor recreation, and 85 per cent participated in some type of outdoor recreation activity other than driving for sight-seeing and relaxation (7). These activities take place on outings, overnight trips, and vacations with most of them occurring during the summer months.

In 1960 the most popular form of outdoor recreation activity was pleasure driving. This was followed by swimming, walking for pleasure, playing outdoor games and sports, bicycling, sight-seeing, picnicking, fishing, attending outdoor sports, boating, nature walks, camping, horseback riding, water skiing, and hiking, respectively (8). By 1980 the most popular outdoor recreation activity will be swimming. Swimming will be followed by playing outdoor games and sports, walking for pleasure, pleasure driving, sight-seeing, picnicking, bicycling, fishing, boating, attending outdoor sports, nature walks, camping, water skiing, horseback riding and hiking, respectively.

It might be noted that in both 1960 and 1980 three of the first ten most popular recreational activities dealt with the use of water. This fact vividly points out again the important role that water oriented activities play in outdoor recreation. Also in need of mention is the fact that the most popular outdoor recreation activities are those requiring little skill. In general, as the popularity of the activity decreases the skill required to take part in the activity increases.

There is every indication that outdoor recreation participation will increase in the future. The reason for the increase is twofold. As one might expect an increase in population will be largely responsible for an increase in participation. Second, there is expected to be an increase in the participation rate.

The increase in the participation rate will be a result of several factors. This increase in participation rate is the subject of the next section.

Factors Affecting Participation in Outdoor Recreation

Although, as previously mentioned, a large majority of the people in the United States take part in some form of outdoor recreation, the rate at which these people participate varies widely; i. e., some people may participate in outdoor recreation activities only once a month or less while others take part in these activities as much as once or twice a week. Many factors have been found that determine the rate at which people participate in outdoor recreation, and it is generally agreed that among all these influencing factors the socio-economic characteristics of the people, the amount of leisure time available for outdoor recreation, and the mobility of the people resulting from automobile ownership bear the greatest significance (9). Thus, a detailed examination of these three factors results in the explanation of the largest portion of the variation in participation rates.

Socio-Economic Characteristics

Of all the socio-economic characteristics that might be considered it has been found in previous research that income, education level, and occupation have the strongest influence on participation in outdoor recreation (10).

As one might intuitively expect, participation in outdoor recreation increases as the level of income increases. This increase is not unbounded however, and both upper and lower limits exist. In most cases the upper limit has been observed at about $10,000.00. Once this upper limit has been exceeded, participation in outdoor recreation declines. Likewise for income levels below about $3,000.00, the lower limit, outdoor recreation participation drops sharply and becomes significant. Looking ahead, as more and more people achieve an income level that is within these limits, especially those approaching the upper limit, there will be an increase in the number of outdoor recreation trips resulting from the increased participation.

The effect of educational level on participation is somewhat similar to income in that the higher educated are greater participants. There is, however, one notable exception to this generalization. Men with a college education are less inclined to participate in outdoor activities than men who only graduated from high school.

Occupation is also a definite influencing factor on the rate of participation in outdoor recreation. In going down the occupational status hierarchy, from professionals to unskilled laborers, the rate of participation decreases. Thus, businessmen, craftsmen and professional people are much greater participants than sales, service, or clerical workers (11).

Leisure Time

During the past 60 years the total amount of leisure time available to the American public has steadily increased, and every indication is that it will continue this past trend. A brief history of this increase in available leisure time was given in a publication by Marion Clawson (12):

> In 1900, the 76 million people in the total population had 667 billion hours (365 days of 24 hours each) for the whole year; of this about 26½ per cent could be classed as leisure-time left over after work, sleep, school, house keeping, and personal care. By 1950, total hours for the entire population had doubled and the proportion of leisure hours had risen to 34 per cent. By 2000, total hours will more than double again, and the proportion in leisure will rise to 38 per cent. A rising percentage of a doubling total obviously means a greatly increasing total of leisuure hours for the whole nation; 177 billion hours in 1900, 453 billion in 1950, and from 1950 to 2000, was due to an increased population; the rest of the increase was due to more hours per person.

Equally as important as the total amount of leisure are the timing and the duration of leisure time activities. If the expected future increases in leisure time come via more and longer paid vacations, this will have the greatest impact on recreation areas suited for vacation use. If this increase in leisure time is realized through a shorter work week, say a four day work week, recreation areas catering to weekend type visitors would receive a large majority of the outdoor recreation participants. On the other hand, should the increase in leisure time be decreasing the total work hours per day, the emphasis would shift to local recreation areas that could be easily reached and used for these few extra hours per day. These examples show how critical the effect of timing of leisure is upon participation in outdoor recreation.

Mobility

The fantastic rate of growth of automobile ownership during the past sixty years, especially since World War II, is easily pointed out by a brief review of the statistics. In 1900 there were only 8,000 registered vehicles. By 1930 this figure had increased to 26.75 million. Between 1930 and 1961 motor vehicle registrations increased by 185 per cent with the 1961 total reaching about 63 million. The greatest increase has been realized since World War II with an approximate increase of 9.2 per cent per year. This meant that by 1961 there was an average of one vehicle for 2.9 persons in the United States (13).

The net result of this increase in vehicle ownership has been extensive freedom of movement for the American people; in other words mobility. Through the automobile the means are now available for vacation trips, weekend trips, and short afternoon excursions. Thus, it can be easily seen what an important role the automobile plays in influencing participation in outdoor recreation activities.

The automobile alone, however, does not determine mobility. The highway system is an equally important factor. The growth of highways in the United States has paralleled the growth of the automobile with a highway system consisting of over 3.5 million roadway miles. Therefore, actual travel time is reduced making the vacation trips, weekend trips, and excursions practical. Thus, the mobility afforded the American public by the automobile and highway system play an essential part in determining participation in outdoor recreation.

Study Recreation Areas

Using the criteria that a recreation area must have a lake and picnic facilities associated with it, a total of fifteen areas were chosen for the purposes of this study. Also because of the problem of data availability, all of the recreation areas were within the State of Georgia. All the areas with the exception of Ida Cason Callaway Gardens were State parks. The areas varied in development from the highly sophisticated Ida Cason Callaway Gardens to the unimproved Alexander H. Stephens State Park. A brief description of the recreation areas selected for the study follows. The geographical location of each of these areas is shown in Figure 1.

Fort Mountain State Park

Fort Mountain State Park is a 2,514 acre area located seventy miles north of Atlanta in Murray County. This park is state-owned and operated, and it has recreational facilities including a 17 acre lake for boating and fishing, a 50 acre camping area, scenic trails, picnic facilities, and sight-seeing attractions. Overnight facilities are limited to one cabin, and the previously mentioned camping area.

Georgia Veterans Memorial State Park

Georgia Veterans Memorial State Park is a state-owned and operated area which has a total land area of 1,300 acres. It is located in the south-central portion of the State adjacant to a Georgia Power Company reservoir, Lake Blackshear. There are facilities for swimming, boating, fishing, and picnicking. There are ten cabins for overnight facilities, but there are no facilities for camping.

Red Top Mountain State Park

Red Top Mountain State Park is located in Bartow County on Allatoona Reservoir which is Corps of Engineers facility. Recreational activities that can be enjoyed at this 1,246 acre area include swimming, camping, boating, fishing, picnicking, and sight-seeing. Overnight facilities include both camping and cabin accomodations. This area is

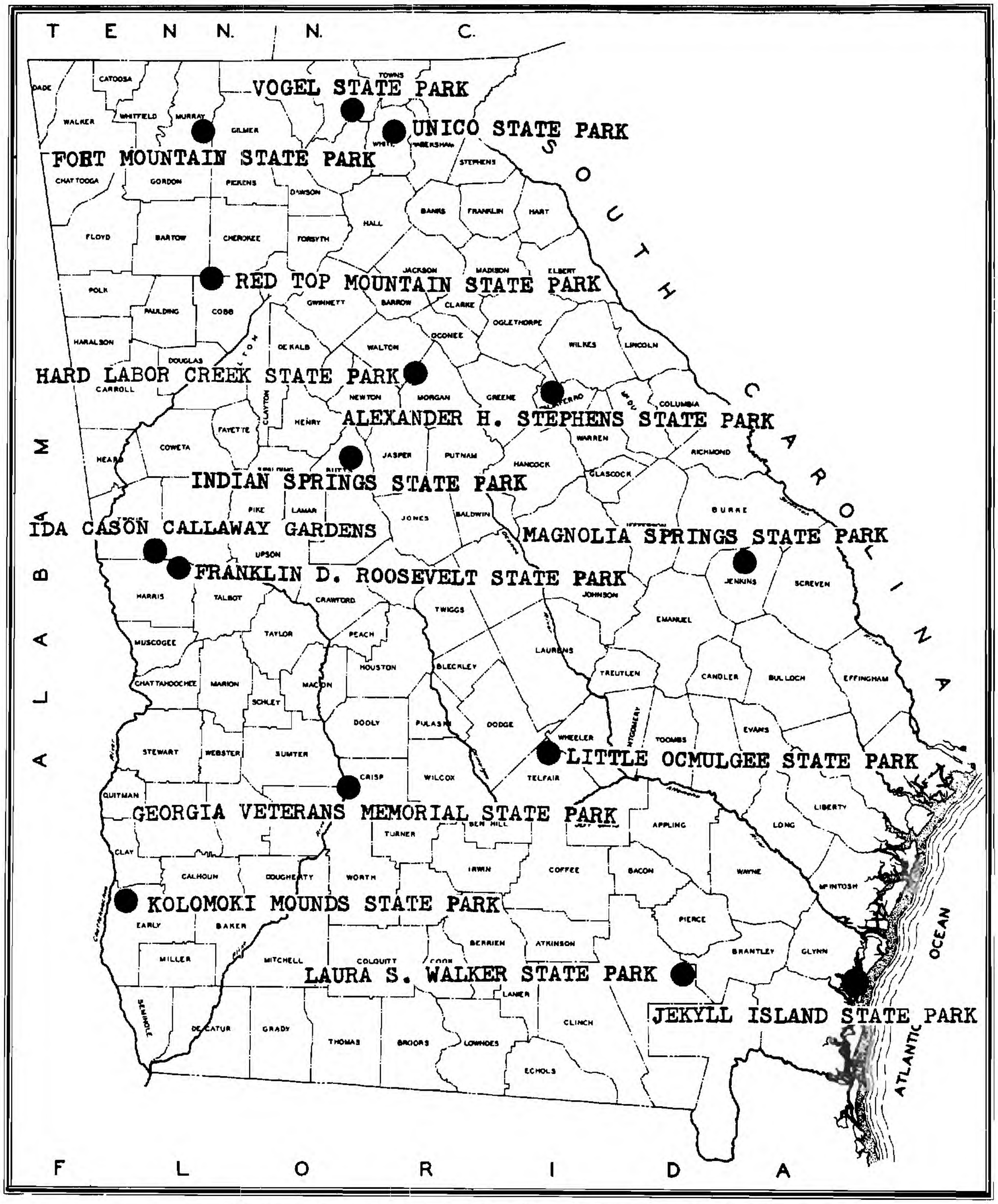

Figure 1. Geographic Location of Study Areas.

owned and operated by the State Parks Department.

Jekyll Island State Park

Jekyll Island State Park is the largest recreation area in the State of Georgia comprising some 11,000 acres. It is state-owned and operated, but the operation of this park is by an authority instead of the State Parks Department. This park is located on the southeast coast of Georgia near Brunswick, and the recreation facilities include camping, swimming, hunting, golf, sightseeing, hiking, and picnicking. Overnight facilities are extensive with 6 motels, several hotels and numerous cottages which are rented by individuals. Camping facilities are limited with only 20 acres reserved for this activity.

Franklin D. Roosevelt State Park

Comprising 5,003 acres of land Franklin D. Roosevelt State Park is located in the west-central part of the state within reasonable travel distance of both Atlanta and Columbus. This park is owned by the state, but it is leased to private individuals for its operation. This park has numerous overnight cabins, but there are no camping facilities. There are facilities for various recreational activities which include swimming, boating, fishing, picnicking and hiking.

Ida Cason Callaway Gardens

Of all the recreation areas in this study Ida Cason Callaway Gardens is by far the most extensively developed. There are facilities for the following recreational activities: horseback riding, golf, swimming, boating, water skiing, fishing, picnicking, hunting, and tennis. Overnight facilities include 155 cottages and a 265 unit motel. There are no facilities for camping however.

Kolomoki Mounds State Park

Located in the southwestern section of the state, Kolomoki Mounds State Park consists of 1,293 land acres. Swimming, boating, camping, fishing, picnicking, hiking, and sightseeing are the recreation activities that a visitor might enjoy at this state-owned and operated park. The only overnight facility is the 10 acre camping area.

Laura S. Walker State Park

Laura S. Walker State Park is a 306 acre recreation area that is owned and operated by the state. This park is located in southeast Georgia near Waycross. This park has recreational facilities for swimming, boating, camping, water skiing, and picnicking. The overnight facility is limited to the six acre camping area.

Hard Labor Creek State Park

Hark Labor Creek State Park is a state-owned and operated recreation area located in the central part of the state in Morgan County. This park contains 5,804 acres of land and two lakes. There are facilities for swimming, boating, fishing, picnicking, camping, and hiking. There are cabins and the camping area which serve as overnight facilities.

Unicoi State Park

Located in the northeast part of the state Unicoi State Park encompasses 270 land acres and a 50 acre lake. This park is owned and operated by the state. This park has facilities for swimming, boating, fishing, camping, hiking, and picnicking. Ten cabins serve as the overnight facilities at this park along with the camping area.

Vogel State Park

Vogel State Park is located in northeast Georgia in Union County and comprises a total of 222 acres of land and a 21 acre lake. Vogel offers facilities for swimming, fishing, picnicking, horseback riding, hiking, sightseeing, boating and camping. This park is owned by the State and leased to private persons for operation. Good overnight facilities are furnished by 31 cabins.

Magnolia Springs State Park

Located in east-central section of the state in Jenkins County, Magnolia Springs State Park has 948 acres of land and two lakes. This park is owned and operated by the state and offers facilities for swimming, picnicking, hiking, fishing, camping, and boating. Overnight facilities include 5 cabins and the 20 acres of camping area.

Alexander H. Stephens State Park

Consisting of 1,161 land acres and a 26 acre lake, Alexander H. Stephens State Park is located in Taliaferro County in northeast Georgia. This park is a state-owned and operated recreation area which offers facilities for swimming, camping, boating, fishing, picnicking, and hiking. The only overnight facilities are the 105 acres of camping area.

Little Ocmulgee State Park

Little Ocmulgee State Park is a 1,397 acre area located in Telfair County in the south central portion of the state. This park also contains a 181 acre lake. Camping, fishing, boating, picnicking, hiking, and swimming are the activities which can be enjoyed with the facilities at this park. Overnight facilities consist of 5 cabins and the 10 acres of camping area.

Indian Springs State Park

Indian Springs State Park is located in central Georgia in Butts

County. This park consists of 510 acres of land and a 105 acre lake. Facilities are available at Indian Springs for swimming, boating, picnicking, camping, fishing, and hiking. This state-owned and operated park offers cabins and camping area for overnight facilities.

CHAPTER III

PREDICTION OF TRIPS ATTRACTED TO OUTDOOR RECREATION AREAS

Past experience has proven that prediction of trips to any type facility cannot be based on a mere extrapolation of past trends. Certainly, this is the case for new facilities which have no history. It is also true in the field of outdoor recreation where growth is taking place at an ever increasing rate. If costly improvements are to be made at recreation areas, the predictions used for the planning of these improvements must be founded on sound engineering prediction techniques in order to avoid economic waste.

Over the past ten years tremendous progress has been made in the development of travel prediction techniques. By and large, the greatest majority of these techniques are mathematical models. It is not the purpose of this thesis to give a complete discussion of the models applicable to outdoor recreation travel, but it is necessary to make comments on these models in order that this study may be viewed in the proper perspective.

There have been four principal approaches utilized in the prediction of outdoor recreation travel, and each has advantages and disadvantages. In the review of these models, it must be remembered that each is unique in the approach to account for different variables affecting travel.

Gravity Model

To date, the most widely used model for the prediction of trip interchanges has been the gravity model. The extensive utilization of this model is primarily due to the fact that it is simple in concept and has had comprehensive documentation. Essentially, the gravity model states, in mathematical terms, that the trip interchange potential between two areas is directly proportional to the relative attraction of each of the areas and inversely proportional to some function of the spatial separation between them. This function of spatial separation is usually expressed in terms of travel distance, travel time or travel costs and is considered a measure of the desire, ability, or necessity of making a trip.

The principal advantages of the gravity model in terms of outdoor recreation travel are its ease in adjustment of the variables in the model; its relatively small data requirements; its flexibility in studying an entire recreation system or each component; and each calculation with a given set of variables produces a unique result.

In spite of these advantages and the widespread usage, the gravity model has inherent limitations. The model is extremely sensitive to the function of spatial separation which cannot be forecast with a high degree of accuracy. Furthermore, the model assumes that the capacity of the recreation area is unlimited, and no allowance is made for the affect of other recreation areas. Also the gravity model is unable to take into account the fact that trips might be made for more than a single purpose without some adjustment.

Linear Programming Models

The linear programming models have been utilized only in the last few years. It is an aggregate approach in that it deals with the behavior of populations. The linear programming models are based on the assumption of optimizing behavior. In the case of recreation travel it is the minimization of the total distance traveled to recreation areas by the entire population. In essence, linear programming models predict trips to recreation areas in such a way that the total distance traveled in making these trips is a minimum.

Although linear programming models are useful, their applicability to real situations is limited by the assumptions used in their development. First, it is assumed that the recreation travel problem has a distance-determined solution. Therefore, it fails to take into account the effect of the varying qualities of the recreation areas. Secondly, the model assumes that all the individuals in a region will work for the good of the entire population and ignore self-interest. Thus, the model eliminates the chance that a trip might be made to an area located a great distance from the origin, and in some cases removes from consideration the chance that a person might wish to make a trip to an area located very close to his origin.

These models are of great value to the outdoor recreation planner who is operating on a limited budget. Because of the nature of these models several alternative solutions to the transportation problem can be easily tested, and the one that seems to best meet the present or projected demand can be chosen. It must be remembered, in the application of this type model, however, that the results may not accurately represent the behavior of the person making the recreation trips or the goals of the planner.

Systems Model

The systems approach is the most recently developed predictive model of travel behavior. The fundamental concept of this technique lies in treating a complex interrelated system as a combination of components which occur repeatedly throughout the system in some identifiable pattern. In applying the systems approach to recreation travel the recreation system is considered to be composed of three components: the origins of recreation trips, the highway system, and the recreation areas. Equations are developed for describing the behavior of each of these components and the interactions between them. This type model has the distinct advantage of having the ability to incorporate all the significant factors affecting recreation travel.

Despite the many advantages of a model of this type, its application is seriously limited by several disadvantages. First, the model assumes that the propensity for outdoor recreation can be measured. To date, this measurement has not been made with any degree of accuracy. Second, the model development is quite complex, and only persons with special training in systems analysis are equipped to use it. Third, the cost of analyzing a recreation system with this model increases sharply with only a slight increase in the complexity of the system. Finally, enormous volumes of data are required to develop the input parameters to the model.

Regression Models

Regression models have increased in popularity and use in predicting present and future travel. In most cases multiple regression techniques have been utilized in the development of relationships for forecasting travel. A more detailed discussion of multiple regression techniques is included in the following Chapter. As mentioned previously, these techniques were applied to travel to recreation areas by Charles C. Cervo (14).

Recreation areas were chosen by Cervo because previous studies had been conducted "where there were no great recreational facilities to act as traffic generators."

The study report concluded that a close relationship existed between trips per family and car ownership. Also a relationship was observed between trips and population density. Thus, relationships were developed for recreation trip productions. In this study no attempt was made to determine the factors or relationships which govern the attraction of trips to recreation areas. Therefore, the study was limited to determining the significant factors and relationships at only one end of the recreation trip--the origin end.

CHAPTER IV

STUDY METHODS

Recognizing the lack of understanding surrounding the attraction of trips to outdoor recreation areas, efforts were made in this research to develop predictive attraction models for outdoor recreation areas exhibiting a wide range of attendance levels. Attendance statistics were obtained for the recreation areas of Fort Mountain State Park, Georgia Veterans Memorial State Park, Red Top Mountain State Park, Franklin D. Roosevelt State Park, Ida Cason Callaway Gardens, Hard Labor Creek State Park, Jekyll Island State Park, Alexander H. Stephens State Park, Unicoi State Park, Indian Springs State Park, Little Ocmulgee State Park, and Magnolia Springs State Park. Selection of study areas was limited to these primarily because of the limitations imposed by availability of suitable data on trips and facilities. Person trips and recreation facilities data were furnished by the Georgia State Park Department for 1960 which was chosen as the study year. The Georgia State Parks Department estimate total person trips for each recreation area by multiplying vehicle counts taken at each area by a factor of 2.5. This factor represents the average persons per vehicle for outdoor recreation trips. This factor is also based on a national average and verified by state wide surveys. Total person trips estimates obtained in this manner are considered to be of sufficient accuracy for the purposes of this study.

Recreation facilities data were obtained from actual counts of existing facilities.

In all cases, multiple regression models were developed relating person trips attracted to recreation areas to available recreation facilities, the socio-economic characteristics of the population in rings surrounding each area or both. In the development of these models, person trips to these areas were used as the dependent variable, and the recreational facilities and socio-economic characteristics of the surrounding region were considered as the independent variables. Essentially, this approach assumes that the variations in total person trips attracted to a recreation area are caused by the variations in the magnitude of certain socio-economic characteristic and/or measures of the quantity of facilities available for recreational activities.

In the development of regions used as the basis for determining the magnitudes of the socio-economic variables, rings of 50, 100, and 150 miles were circumscribed around each recreation area. Since socio-economic data were available on a county basis, county boundaries were utilized to define the limits of each analysis ring (15).

In many instances, due to the lack of coincidence between actual ring boundaries and county lines, a decision had to be made on whether a county which was only partially within an actual ring would be included in the analysis ring. This decision was made by considering the location of the county seat. If the county seat was located inside the actual ring, it was included in the analysis ring, and its boundary determined the ring boundary. Otherwise, it was excluded from that particular ring. For analysis purposes when socio-economic characteristics of the outer zones were considered, the inner zones were also included in the aggregation, e. g., if the 150 mile ring population were the particular variable being studied, both the 100 mile and 50 mile populations would be included. In other words, the outer rings are mutually inclusive of all rings closer to the recreation area. The designation of rings in this manner was an effort to evaluate the influence of travel distance on outdoor recreation trips.

Prior to regression analysis, a simple correlation matrix involving all variables was developed. The calculations necessary in the development of this matrix were made with the aid of an electronic computer. In effect, a simple correlation matrix indicates statistically the relationship existing between any variable and all other variables by means of correlation coefficients, which will be described in detail in a subsequent section of this Chapter. This approach eliminates to a large extent the trial and error process in choosing significant variables to be included in regression equations and provides the initial starting point for regression analysis. Also, this approach enables the analyst to avoid the all too common pitfall of including highly related independent variables in the same regression equation. This was amply pointed out in a publication by the Bureau of Public Roads:

> When two highly correlated variables are allowed to enter the same equation, not only is the effect of each variable on the dependent variable clouded, but the least squares regression technique tends to break down. (16)

An example of a simple correlation matrix is shown in Table I.

Linear Regression Analysis

All models were developed in this study using simple and multiple linear regression techniques. Linear regression analysis is a statistical procedure in which the relationship between two or more variables

Table 1. Simple Correlation Matrix

	Total Trips	Population (50-Mile Run)	Employed Persons (50-Mile Run)	Cabin Floor Space
Total Trips	1.000	0.129	0.098	0.885
Population	0.129	1.000	0.959	0.191
Employed Persons	0.098	0.959	1.000	0.166
Cabin Floor Space	0.885	0.191	0.166	1.000

may be expressed in a linear equation. Therefore, linear regression involves the determination of coefficients in a linear equation such that the resulting line or surface best fits a given set of observations. In the case of simple linear regression, regression analysis involves the determining of the constants a and b in an equation which would have the following form:

$$Y = a + bx$$

An example of such a simple linear regression equation is given by the relationship between recreation trip attractions and total cabin floor space area at recreation areas:

Attracted Trips = 13,582 (Total Cabin Floor Space in Sq. Ft.) + 89,755.96

A scatter diagram and simple regression line for this relationship is exhibited in Figure 3.

Multiple linear regression is somewhat similar to the above approach in that coefficients and constants must be determined. In other words, the coefficients b_1, b_2, b_3 and A in the following equation must be evaluated:

$$Y - b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots + A.$$

In multiple linear regression, the variations in the magnitude of dependent variables is assumed to be the result of variations in two or more independent variables. The methods utilized in developing the coefficients for the independent variables are essentially the same as that used in the simple linear regression case. However, the result of such an equation is not a line but a surface in n-space depending on the number of independent variables included in the equation.

Regression, whether simple or multiple, addresses itself to the problem of determining the line or surface which "best-fits." The method which was chosen in this study was the least squares method. This method can best be described as the minimization of the following function (Q):

$$Q = \sum_{u=1}^{n} (Y_u - \overline{Y}_u)^2$$

Where: Y = observed value of the independent variable

$\overline{Y}$ = estimated value of the dependent variable

n = total number of observations

Thus, the least squares methodology produces a line or surface of "best-fit" such that the sum of all of the square of the errors made in estimating each observation is a minimum. Although the necessary calculations can be done by hand, in many cases this becomes quite time consuming. Therefore, for the purposes of this study, these calculations were made with the aid of an electronic computer.

Statistical Measures of Regression and Correlation Analysis

In the development of regression equations certain measures are used to evaluate the statistical significance of both the whole model and the individual variables. Thus, it is extremely important to fully understand the measures which are discussed in the paragraphs below. The importance of these measures and the thoughtfulness necessary in the development of regression equations has been pointed out in a publication by the Bureau of Public Roads (17):

Since multiple regression is a statistical analysis technique, it is important that various standard tests of validity be considered and that the results be evaluated by these means. Multiple regression is only as accurate and as useful as the validity of the assumptions that are made and the statistical significance of the results obtained.

It is also important that a great deal of thought be applied to both the logic of the equation and the statistical evaluations to determine the reasonableness of the results. It is entirely possible to produce equations which meet all the various statistical criteria and yet, exhibit no causal relationship between independent. . . variables and trip generation. In order to forecast such a causal relationship is essential.

Measures of Degree of Correlation for Regression Model

Once a predictive model has been developed utilizing regression techniques, it is necessary to know the effectiveness of the regression equation in "explaining" the relationship between the independent and dependent variables. There are several statistics which can be calculated that give an indication of this effectiveness. Four such statistics were used in this study, and the meaning of each is stated below. For a more detailed treatment of these statistics, reference can be made to a number of textbooks (18, 19).

Coefficient of Multiple Correlation

The square root of the coefficient of multiple determination is the coefficient of multiple correlation. It is basically a measure of the degree of association existing between the dependent and independent variables. The value of the measure also has a range between 0 and 1 with the higher values being indicative of closer association between the dependent and independent variables. In the respect that the coefficient of multiple correlation tends to overestimate the association between the dependent and independent variable, it is subordinate to the coefficient of multiple determination.

Coefficient of Multiple Determination

The coefficient of multiple determination is a measure of the amount of the total variance in the dependent variable that is explained by the variations in the independent variable or variables. The value of the coefficient of multiple determination may lie between 0 and 1, and for the situation where the coefficient of multiple determination equals one it can be stated that all the variation in the dependent variable is explained by the variations in the independent variables. Likewise, high values of the coefficient of multiple determination indicate a close degree of association between the dependent and independent variables and low values indicate little or no association.

Standard Error of Estimate

The standard error of estimate is actually a measure of the scatter or dispersion of the observed data points about the regression line. Thus, a small standard error of estimate is indicative of a close agreement between the observed values and the values predicted by the regression line. The units of the standard error of estimate are the same as the units used for the dependent variable which for the purpose of this study was person trips. In many cases the standard error of estimate is expressed as a percentage of the mean of the dependent variable. It is meaningful to express a measure of accuracy in this relative manner since the mean value is the most likely value to be estimated.

The F Ratio

The F Ratio can be defined as the ratio of the variation which is explained by the model to the variation not explained. Therefore, it may be generally stated that a high value of the F Ratio indicates a relatively good prediction model. In mathematical terms, a high F Ratio would denote that the slope of the regression line was significantly different from zero.

Measures of Degree of Significance for Individual Variables

In dealing with regression equations it is not sufficient to merely know the effectiveness of the total mathematical model. Additional insight into the significance of the individual variables is necessary. In this study the significance of each variable was indicated by its regression coefficient, standard error of regression coefficient, partial correlation coefficient, and the t-test. The meaning of each of these measures is discussed briefly below.

The Regression Coefficient

In simple linear regression the value of the regression coefficient denotes the number of unit changes of the dependent variable for each unit change in independent variable. In the case of multiple linear regression the value of each regression coefficient indicates the effect each corresponding independent variable has on the estimate of the dependent variable in units of the original data when all other independent variables are held constant at their mean value. Likewise, the value of the regression constant is the value that the dependent variable would have if all the independent variables were held constant at their means. The previous statements imply that the value of the regression coefficient for a particular variable may not remain constant as more independent variables are added to the regression equation. Therefore, care must be exercised in evaluating the regression coefficient giving due consideration to the nature of the model and the remaining independent variables.

Standard Error of the Regression Coefficient

Simply stated, the standard error of the regression coefficient is the probable range in which the "true" value of the regression coefficient is expected to lie, i. e., it furnishes a measure of the accuracy of the estimated regression coefficient. By assuming that the observed data is normally distributed about the regression plane, a confidence interval can be obtained utilizing the t-test, which is discussed in more detail below.

Partial Correlation Coefficient

The partial correlation coefficient is a measure of the correlation that exists between the dependent variable and each of the individual independent variables, while eliminating the linear tendency of any of the other independent variables to influence the relationship. The partial correlation can be further defined as a measure of the extent to which the unexplained portion of the variation in the dependent variable is explained by a particular independent variable in a given multiple regression equation. By squaring the partial correlation coefficient, the amount which that variable reduces the variation after all other variables are taken into account is obtained.

The t-test

The student's t-test or t-test is used to indicate whether or not the estimating equation is utilizing the independent variables efficiently. Furthermore, the t-test is used in examining the probability that an estimated regression coefficient could have been obtained by chance when the true value was actually zero. In this study the t-test was carried out at the five per cent level of significance, which means that making a wrong decision about the regression coefficient being different from zero would be expected purely by chance only 5 in 100 times.

There are certain assumptions that should be noted regarding the nature of the independent and dependent variables. These are: (1) the dependent variable is a random variable, and the independent variable is an observation without error; (2) for a given value of the independent variable, there is a corresponding set of dependent variables which is normally and independently distributed; the variance of all the sets of dependent variables is the same; and the value of the error, involved in estimating the dependent variable, is normally and independently distributed with mean zero and known variance (20). Since there were insufficient observations to carry out conclusive tests to determine if all the requirements were met some caution is required in interpreting and using the results. Since regression coefficients are little affected by deviation from the above requirements, the most serious consequence of this departure would be the misleading values computed for the correlation statistics (correlation coefficient, coefficient of determination, standard error, etc.)

CHAPTER V

STUDY RESULTS

In this study, linear regression models were developed in three categories according to the type of independent variable or variables utilized in the linear regression equations: (1) socio-economic models, (2) recreation facilities models, and (3) socio-economic and recreation facilities models. A total of four models are described in the following paragraphs of this Chapter.

As mentioned earlier, fifteen recreation areas formed the basis for analysis of the relationship between trip attractions and both recreation facilities and socio-economic characteristics. A wide range of person trip attractions was observed for these recreation areas as shown in Table 2. In developing models involving the variables measuring recreation facilities it was necessary to exclude Jekyll Island State Park and Ida Cason Callaway Gardens due to the incompatability of this data with that of the remainder of the areas. Generally, this incompatability of data was a result of a lack of sufficient detail to be consistent with the remainder of the data. This fact must be considered when comparisons of the three models are made.

In the following equations several symbols are used to refer to certain variables: Y_T refers to the total annual person trips attractions to a recreation area; Y_P refers to total annual person trips attractions per 1,000 persons in a given ring; the symbol $x_{p1,\ 2,\ 3}$ is used to denote the population in the particular ring under study; the symbol x_c applies

Table 2. Person Trips Attracted to Study Recreation Areas

Recreation Area	Person Trips
Fort Mountain State Park	95,084
Georgia Veterans Memorial State Park	300,570
Red Top Mountain State Park	127,596
Franklin D. Roosevelt State Park	325,000
Ida Cason Callaway Gardens	350,892
Hard Labor Creek State Park	110,655
Laura S. Walker State Park	86,067
Vogel State Park	475,998
Kolomoki Mounds State Park	112,620
Jekyll Island State Park	253,410
Alexander H. Stephens State Park	42,811
Unicoi State Park	155,509
Indian Springs State Park	200,432
Little Ocmulgee State Park	105,528
Magnolia Springs State Park	137,568

to cabin floor space; and x_{cm} is the symbol utilized to denote camping area.

Socio-Economic Model

Development of a trip attraction model utilizing only socio-economic variables result in Equation (1):

$$Y_p = -0.000029X_{p2} + 158$$

A correlation coefficient of 0.485 indicates that there is little relation between the two variables in this equation. The coefficient of determination, 0.234, implies that only 23 per cent of the variation in person trips per thousand person in the 100 mile ring was explained by this equation. As would be expected with such low correlation the standard error is quite high being 62 per cent of the mean or 54.33 trips per thousand persons in the 100 mile ring. A low F-ratio of 2.96 also verifies the lack of a significant relationship between the two variables. A value of 1.72 for the t-test suggest that the regression coefficient might possibly be zero. These statistics indicate that this equation is of little value in predicting recreation person trip attraction. The scatter diagram and regression line shown in Figure 2 reinforce this conclusion.

By referring to the simple correlation matrixes shown in Appendix B, Table 8, it will be noted that once population had been used as a variable in the regression equation no other socio-economic variables could be added because of the high correlation existing between population and all the remaining socio-economic variables. In fact, only one socio-economic variable can be utilized in any regression equation due to the high correlation exhibited between all socio-economic variables. This

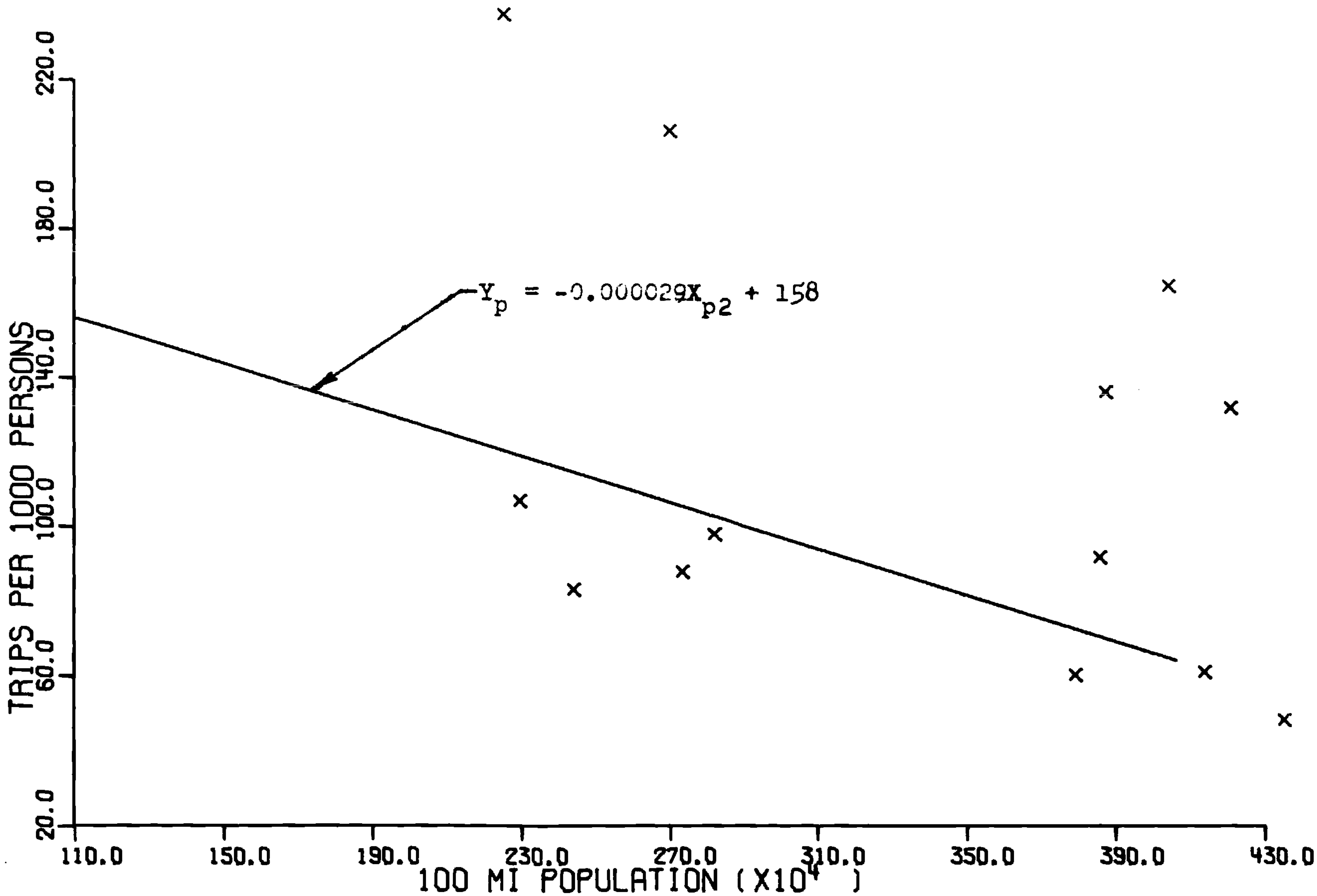

Figure 2. The Relationship of Person Trips to the Total Population Within the 100 Mile Analysis Ring.

high degree of correlation is brought about by the aggregation of a large number of people in the analysis rings. Aggregation of large segments of population such as in the analysis rings tends to damp the population characteristic variations.

Recreation Facilities Models

A total of six variables, which reflected in quantitative terms the recreational facilities at the test areas, were evaluated to determine their relationship to person trip attractions to outdoor recreation areas. Two equations resulted from the examination of these variables:

$$Y_T = 13.58x_c + 89,756 \qquad (2)$$

and

$$Y_T = 12.67x_c - 1229.25x_{cm} + 116,195 \qquad (3)$$

Equation (2) was highly significant with an F-Ratio of 39.63. The correlation coefficient for this equation was 0.8847 which also suggests a degree of correlation existing between person trip attractions and cabin floor space. The coefficient of determination of 0.793 indicates that over 79 per cent of the variation in person trip attractions was explained by this model. The scatter diagram and regression line shown in Figure 3 indicate that there is relatively close agreement between observed and predicted values. Table 23 in Appendix D gives an area-by-area comparison of computed and observed person trip attractions.

It is interesting to note that in equation (2) there are over 13 trip attractions for every unit of floor space. Also the regression constant indicates that there will be some 89,756 trip attractions when there are no overnight cabins at a recreation area. This agrees very well with the

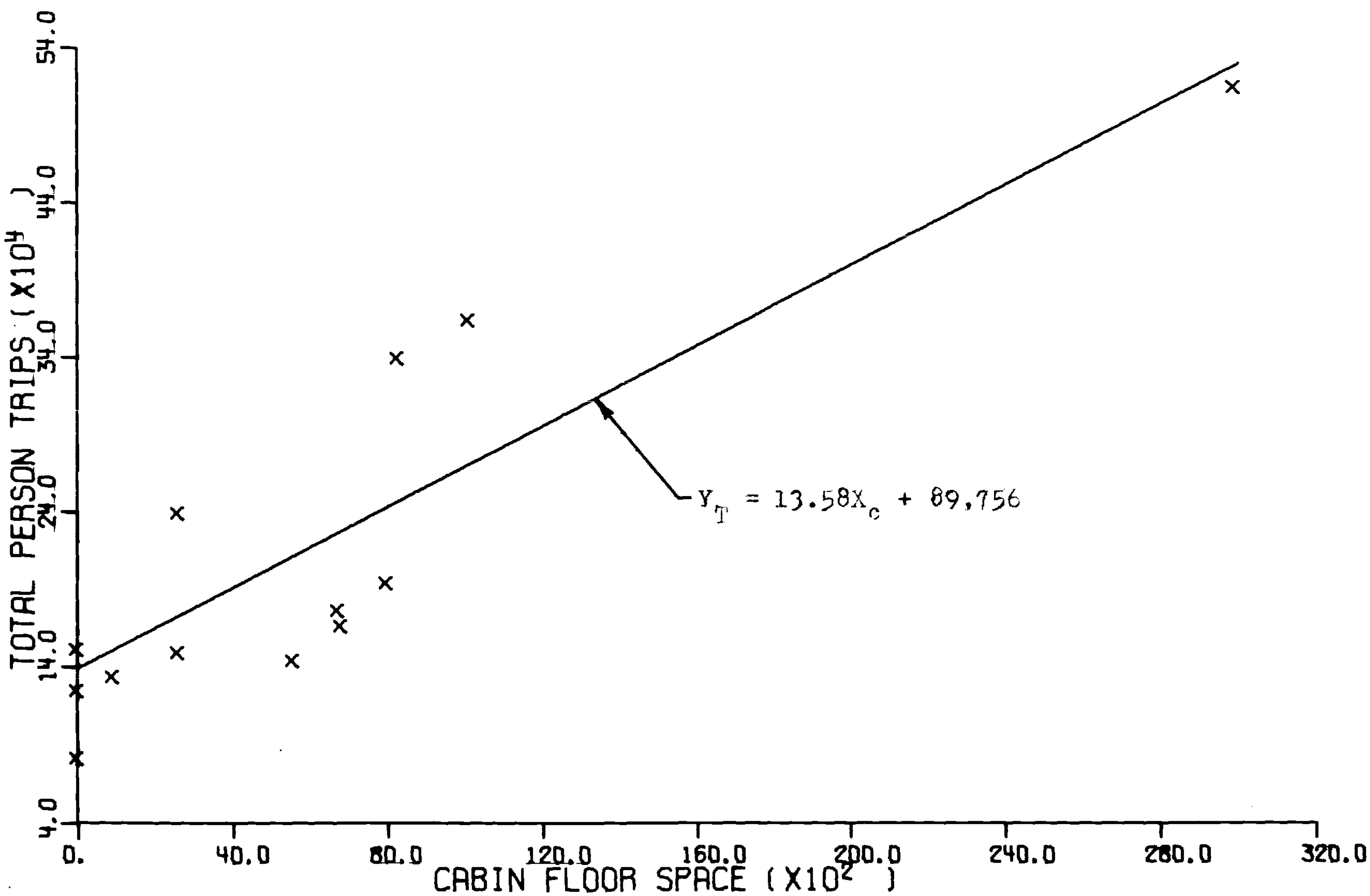

Figure 3. The Relationship of Person Trip Attractinns to Overnight Cabin Floor Space.

three observations at which there were no overnight cabins.

Equation (3) was obtained by the addition of the camping area variable to equation (2). This additional variable had the effect of increasing the correlation coefficient to 0.900 and the coefficient of determination to 0.811. However, the standard error was decreased by a small amount, from 59,320 to 58,064. When expressed in terms of a percentage of the mean, the decrease was from 33.8 to 33.2 per cent.

It is important to note the negative regression coefficient for the camping area variable. This means that as camping area increases trip attractions decrease as long as cabin area remains constant. A logical explanation of this implication seems impossible, and the incorporation of this variable in the model should be seriously questioned. Examination of the t value, 1.22, and the partial correlation coefficient, 0.359, gives a further indication that including this variable in the model is unwarranted. A scatter diagram and regression line for equation (3) is shown in Figure 4.

Additional statistical data for equations (2) and (3) is given in Appendix D.

<u>Socio-Economic and Recreation Facilities Models</u>

Equation (4) is the best person trip attraction model developed utilizing both socio-economic and recreation facilities variables:

$$Y_T - 13.49x_c + 0.013x_{p2}\ 68,863$$

Statistics for determining the degree of correlation for the model as a whole indicate that this model is highly significant. The multiple correlation coefficient is 0.887, and the coefficient of determination is

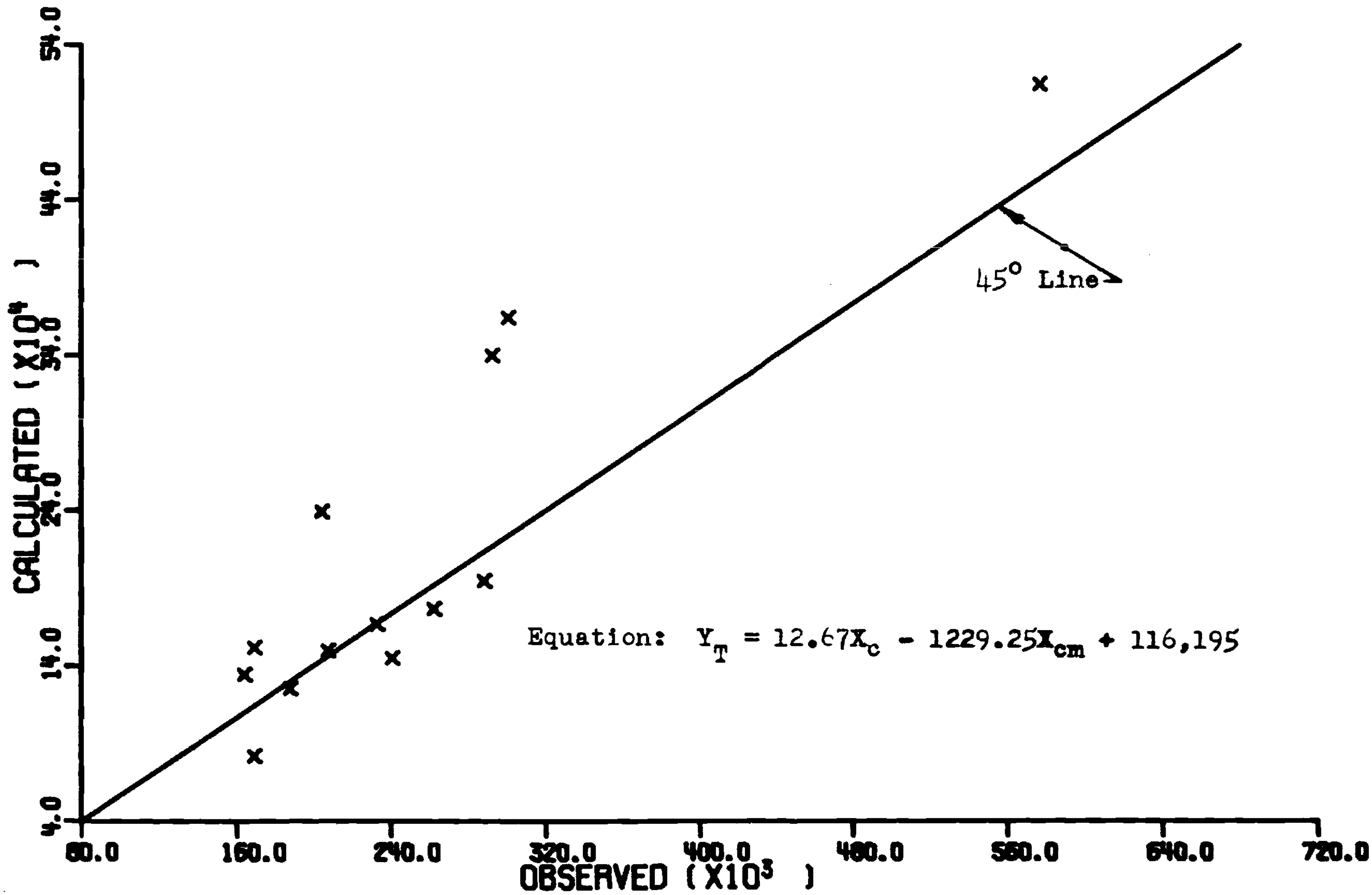

Figure 4. The Relationship of Calculated Person Trip Attractions to Observed Person Trip Attractions.

0.787. Also the F Ratio is relatively high, 18.45, and the standard error is only 35.2 per cent of the mean.

However, an entirely different picture is obtained by looking at the statistics for the individual independent variables. The t value for the regression coefficient for population is only 0.437 and partial correlation coefficient is 0.137. For the cabin floor space variables the t value and partial correlation coefficient are 6.00 and 0.885, respectively. Thus, it is apparent that this equation cannot adequately serve as a predictive model.

Summary

A total of four models was developed in the three model categories. Only one of these, equation (2), was found to be statistically significant and useful as a predictive model. Thus, by utilizing equation (2), predictions of the total number of person trips attracted to a particular outdoor recreation area can be made with reasonable accuracy.

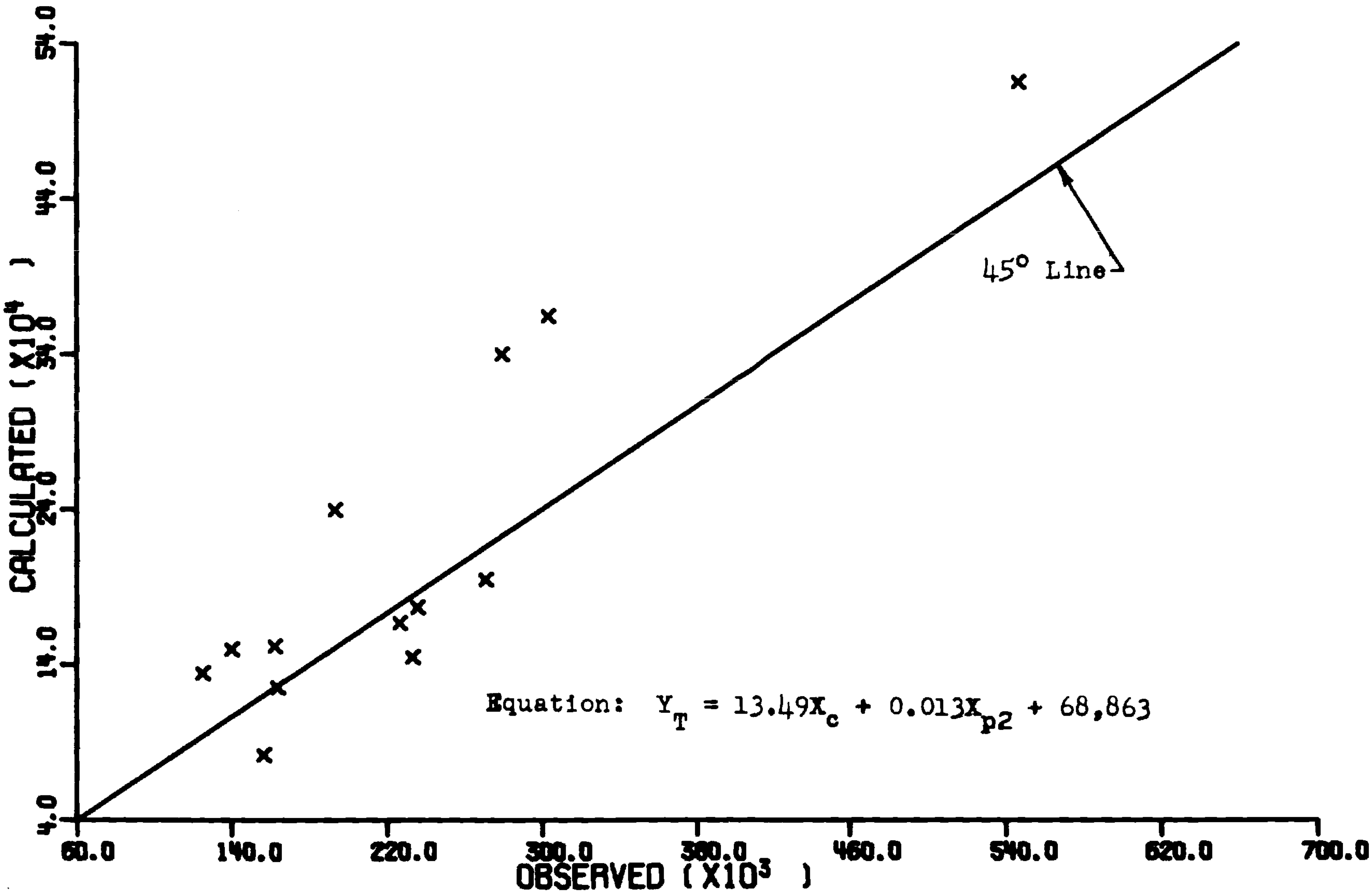

Figure 5. Relationship of Calculated Person Trip Attractions to Observed Person Trip Attractions.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

1. Total person trip attractions to outdoor recreation areas are closely related to the existing recreational facilities at these areas.

2. Although socio-economic characteristics of the population play a predominant role in the determination of participation in outdoor recreation, the socio-economic characteristics of the people in the region surrounding a recreation area have little statistical influence on trips to that particular recreation area. The primary reason is that outdoor recreation areas are not isolated, and the mobility provided by the automobile enables persons to chose from a number of recreation areas depending on the recreational facilities provided at the area.

3. Total person trip attractions to outdoor recreation areas are most closely related statistically to overnight cabin floor space which is a measure of the overnight facilities provided visitors.

4. Although recreation facilities other than cabin floor space were not found to be statistically significant, it is considered that with more data and more detailed stratification of the data additional significant variables will be found.

5. The quality of the facilities at the recreation areas was not taken into account in this research. It is recommended that there be further research to examine the exact influence this factor might have on person trip attraction.

6. An attempt was made in this research to develop an equation which incorporated a variable reflecting the influence of the travel distance on person trip attractions. However, equations utilizing these variables, i. e., the socio-economic variables within the various analysis rings, had no statistical significance. It is considered that travel distance might influence person trip attractions. Therefore, it is recommended that further research be conducted to determine the effect of travel distance on person trip attractions to outdoor recreation areas.

7. The intensity of development at outdoor recreation areas was not incorporated in this study. Therefore, it is recommended that future research determine the extent to which person trip attraction to recreation areas is affected by intensity of development at recreation areas.

8. During the course of this research, it was noted that there is insufficient accurate data on person trips to recreation areas; notably, almost a complete lack of origins of the trip makers. In order to provide efficient transportation facilities, it is imperative that both the origin and destination of trips be known. Thus, it will be necessary in the future that the origins of recreation trips be determined accurately.

APPENDIX A

OTHER EQUATIONS STUDIED

In this Appendix additional regression models are presented along with their related statistics. It will be noted that the statistical measures for these models are lower than the statistical measures of the regression models given previously. However, it is considered that for completeness these models should be included as part of this thesis.

Table 3. Trips Per 1000 Persons Related to the Total Population Within the 50-Mile Analysis Ring

REGRESSION EQUATION: $Y_p = -0.00043X_{p1} + 691$

where Y_p = Total annual trip attractions per 1000 persons to a given recreation area.

X_{p1} = The total population within the 50-mile analysis ring for each recreation area.

Observation	Calculated Trips Per 1000 Persons	Observed Trips Per 1000 Persons
1	402.00	141.88
2	520.96	763.12
3	64.48	87.75
4	437.35	430.93
5	429.43	535.89
6	422.78	564.22
7	533.43	308.65
8	601.26	415.05
9	113.03	82.50
10	541.06	447.92
11	564.71	628.71
12	500.04	310.91
13	543.80	125.62
14	551.73	327.31
15	87.50	143.10

Correlation Coefficient, $R = 0.468$
Coefficient of Determination, $R^2 = 0.219$
Standard Error, $S(Y_p) = 356.18$
Standard Error As Percentage of Mean = 84.5
F Ratio = 3.64

Statistical Data for Regression Coefficients

	50 Mile Population X_{p1}
Level of Significance	5%
t-test Value	1.91
Standard Error	0.000225

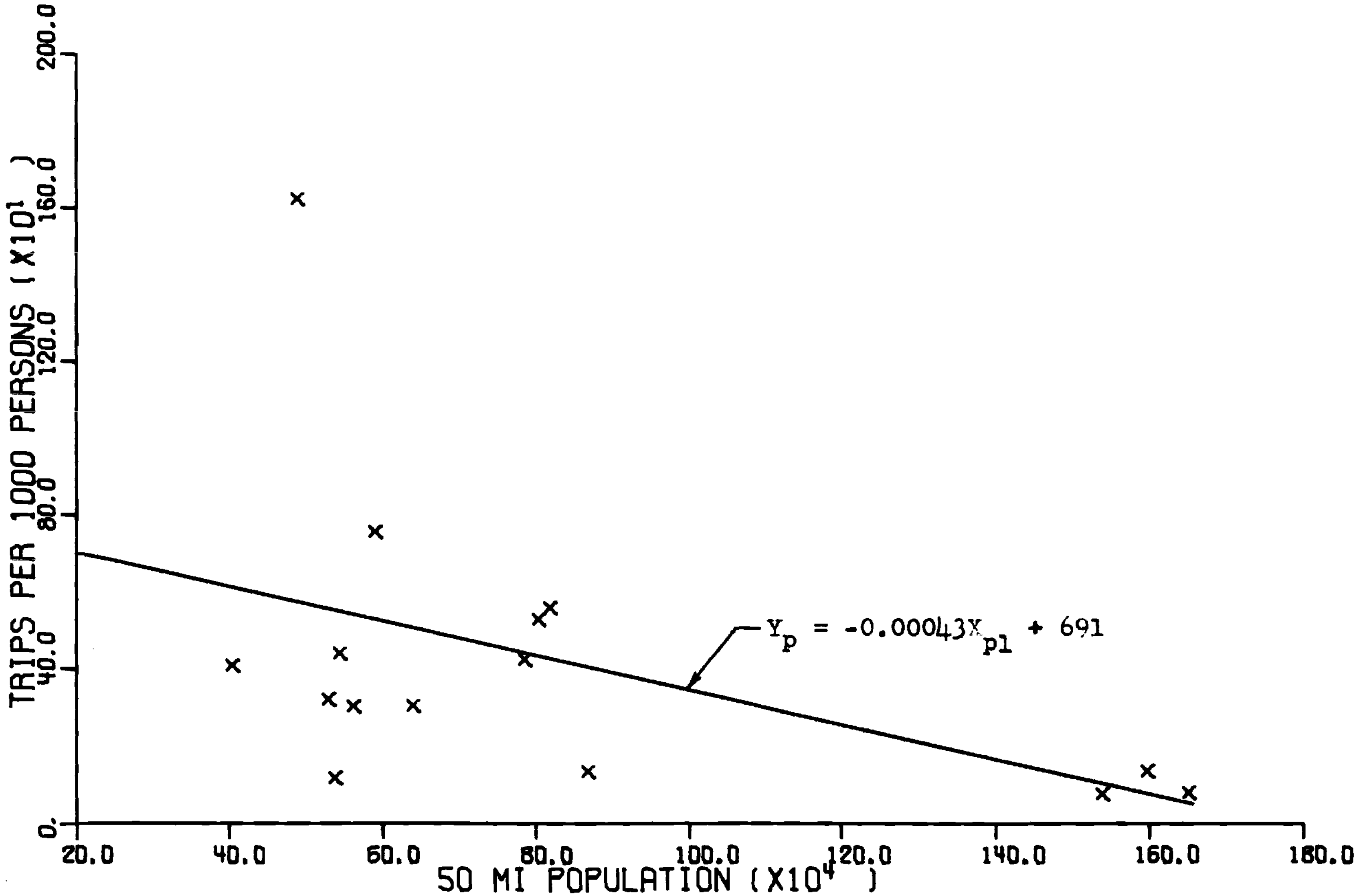

Figure 6. The Relationship of Trips Per 1000 Persons to the Population Within the 50 Mile Analysis Ring.

Table 4. Trips Per 1000 Persons Related to the Total Population Within the 150-Mile Analysis Ring.

REGRESSION EQUATION: $Y_p = -0.00000996X_{p3} + 121$

where Y_p = Total annual trip attractions per 1000 persons to a given recreation area.

X_{p3} = The total population within the 150-mile analysis ring for each recreation area.

Observation	Calculated Trips Per 1000 Persons	Observed Trips Per 1000 Persons
1	29.43	15.31
2	52.13	76.47
3	30.27	20.83
4	70.27	120.11
5	40.81	64.13
6	36.22	63.49
7	61.66	37.86
8	66.81	35.02
9	39.62	21.33
10	28.71	24.75
11	33.62	82.23
12	51.94	34.82
13	37.81	7.97
14	48.22	24.41
15	40.54	39.34

Correlation Coefficient, R = 0.439
Coefficient of Determination R^2 = 0.192
Standard Error, $S(Y_p)$ = 28.68
Standard Error as Percentage of Mean = 64.2
F Ratio = 3.09

Statistical Data for Regression Coefficients

	150 Mile Population X_{p3}
Level of Significance	5%
t-test Value	1.76
Standard Error	0.00000566

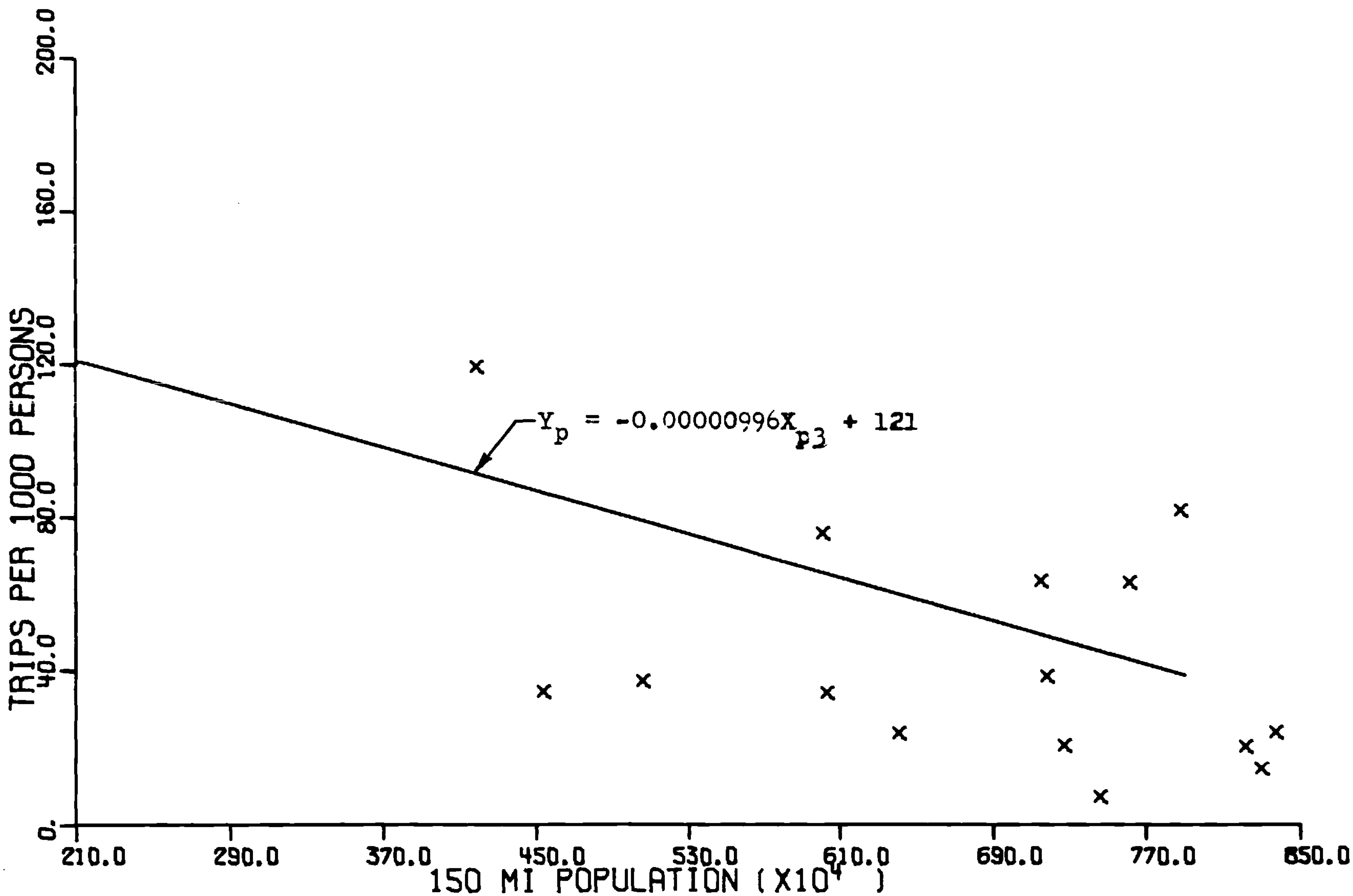

Figure 7. The Relationship of Trips Per 1000 Persons to the Population Within the 150 Mile Analysis Ring.

Table 5. Total Person Trip Attractions Related to the Overnight Cabin Floor Space and the Length of Scenic Trails.

REGRESSION EQUATION: $Y_T = 14.89X_c - 37,832.78X_s + 109,493$

where Y_T = Total annual person trips attracted to a given recreation area.

X_c = The overnight cabin floor space in square feet at a given recreation area.

X_s = The total length of scenic trails in miles at a given recreation area.

Observation	Calculated Total Persons Trips	Observed Total Person Trips
1	85,358	95,084
2	213,856	300,570
3	154,434	127,596
4	222,335	325,000
5	90,577	112,620
6	109,493	86,067
7	129,109	110,655
8	209,687	155,509
9	498,275	475,998
10	183,882	137,568
11	90,577	42,811
12	162,232	105,528
13	125,623	200,432

Correlation Coefficient, $R = 0.890$
Coefficient of Determination, $R^2 = 0.793$
Standard Error, $S(Y_T) = 60,761$
F Ratio = 19.13

Statistical Data for Regression Coefficients

	Cabin Floor Space X_c	Scenic Trail Length X_s
Level of Significance	5%	5%
t-test Value	5.14	0.69
Standard Error	2.89	54,353
Partial Correlation Coefficient	0.852	0.0215

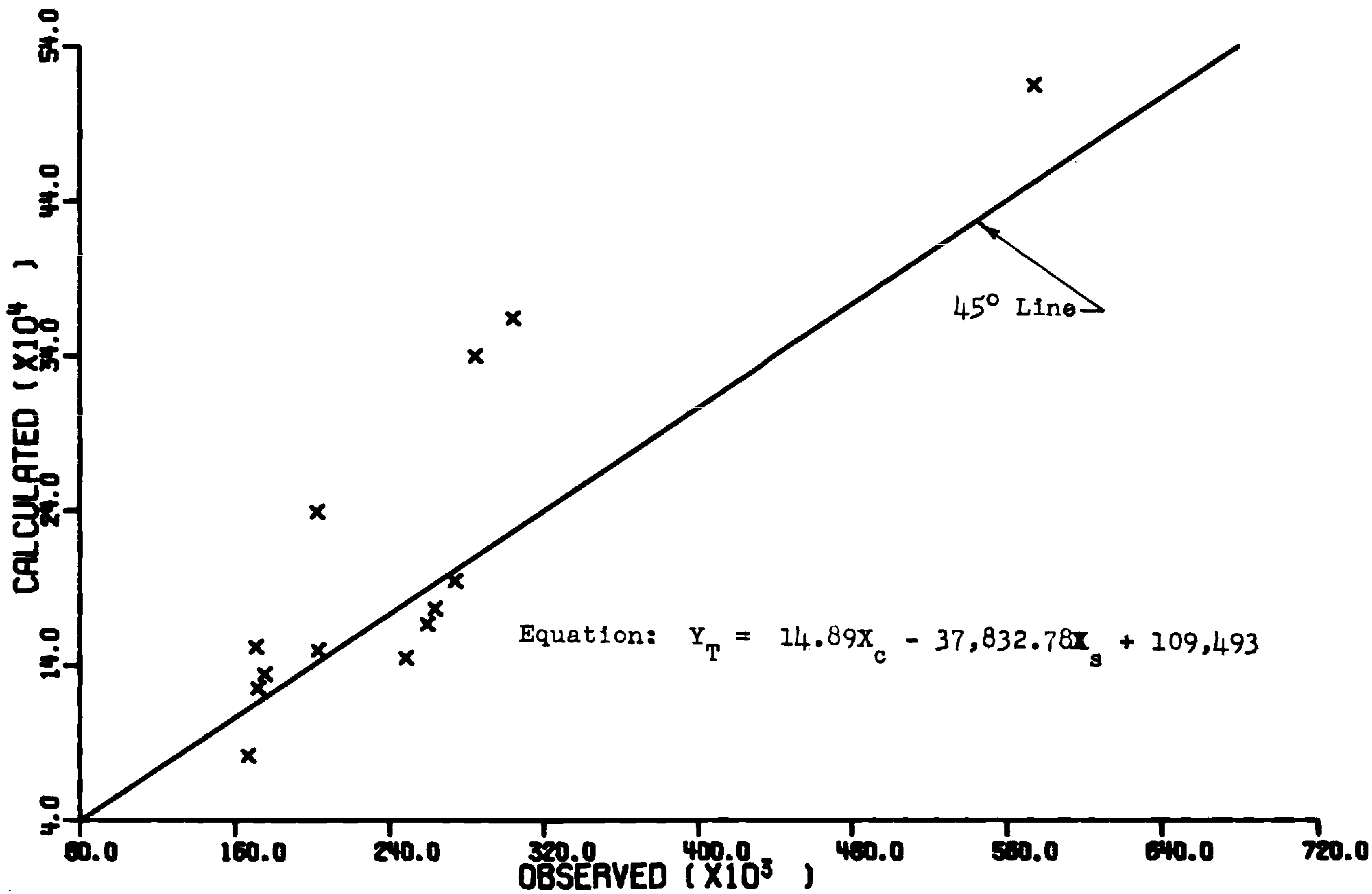

Figure 8. The Relationship of Calculated Person Trips to Observed Person Trips.

Table 6. Total Person Trip Attractions Related to the Overnight Cabin Floor Space and the 100 Mile Analysis Ring Population Density.

REGRESSION EQUATION: $Y_T = 13.75X_c - 100.91X_{pd} = 97,067$

where Y_T = Total annual person trips attracted to a given recreation area.

X_c = The overnight cabin floor space in square feet at a given recreation area.

X_{pd} = The population density in the 100 mile analysis ring surrounding a given recreation area.

Observation	Calculated Total Persons Trips	Observed Total Person Trips
1	96,617	95,084
2	205,817	300,570
3	180,839	127,596
4	225,536	325,000
5	91,864	112,620
6	93,058	86,067
7	124,008	110,655
8	195,545	155,509
9	495,755	475,998
10	184,929	137,568
11	87,672	42,811
12	169,843	105,528
13	123,966	200,432

Correlation Coefficient, R = 0.885
Coefficient of Determination, R^2 = 0.783
Standard Error, S (Y_T) = 62,127
Standard Error as Percentage of Mean = 35.5
F Ratio = 18.08

Statistical Data for Regression Coefficients

	Cabin Floor Space X_c	100 Mile Population Density X_{pd}
Level of Significance	5%	5%
t-test Value	5.57	0.17
Standard Error	2.47	598.72
Partial Correlation Coefficient	0.870	0.053

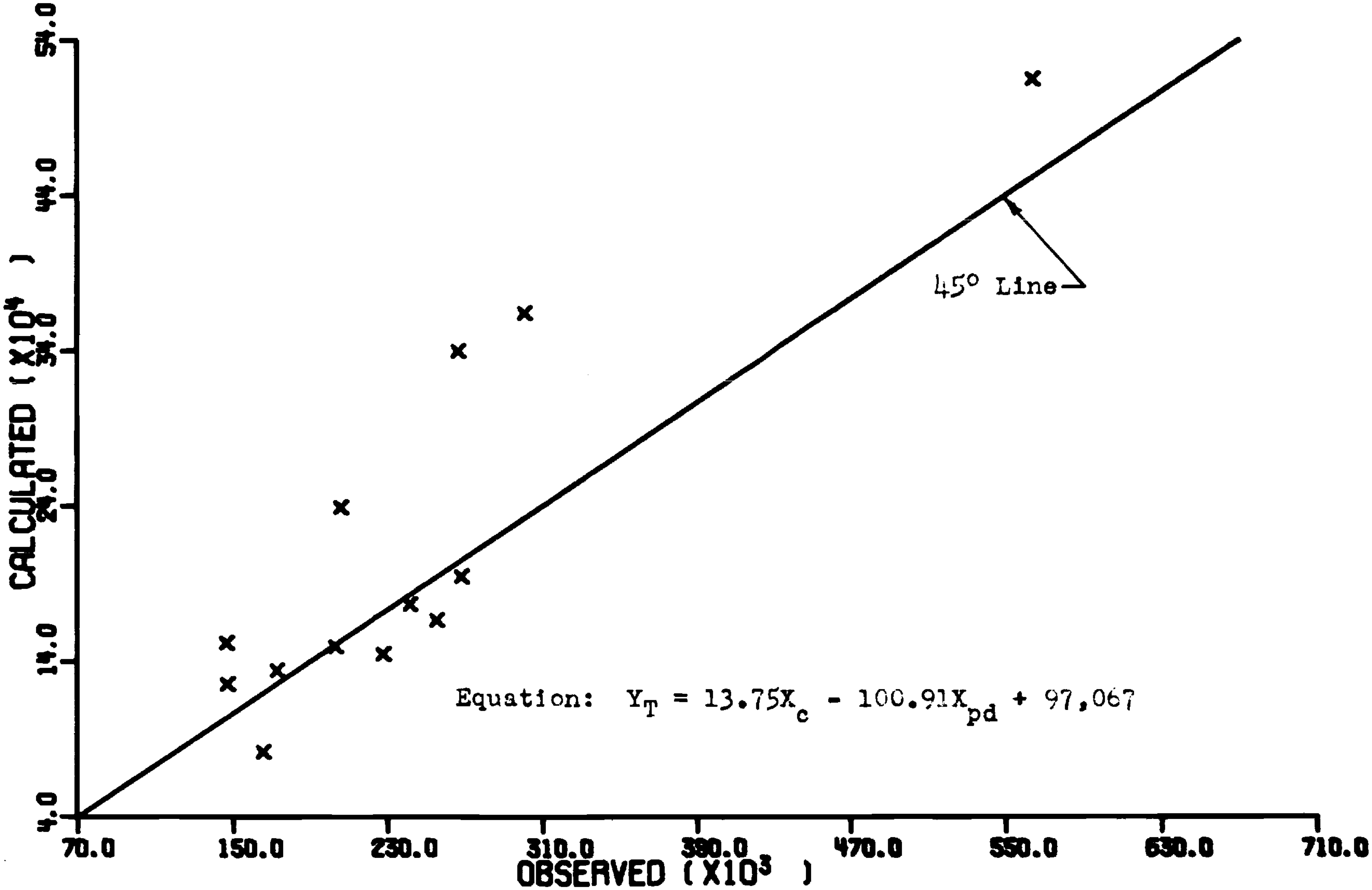

Figure 9. The Relationship of Calculated Person Trips to Observed Person Trips.

APPENDIX B

SIMPLE CORRELATION MATRIXES

Table 7. 50 Mile Simple Correlation Matrix

	Total Trips	Trips per 1000 Persons	Trips per Family	Population	Total Occupied Dwelling Units	Owner Occupied Dwelling Units	Total Automobiles	Automobiles per Capita	Automobiles per Family	Number of Employed Persons	Families	Population Density	Land Area of Recreation Area	Lake area	Overnight Cabin Area	Camping Area	Scenic Trails	Picnic Tables
Total Trips	1.000	0.838	0.838	0.111	0.172	0.172	0.171	0.086	0.145	0.111	0.125	0.087	0.015	0.047	0.855	0.454	0.496	0.216
Trips per 1000 Persons		1.000	0.999	0.468	0.467	0.429	0.452	0.016	0.374	0.439	0.421	0.371	0.028	0.198	0.457	0.581	0.058	0.063
Trips per Family			1.000	0.481	0.480	0.436	0.456	0.126	0.402	0.466	0.448	0.386	0.069	0.173	0.542	0.580	0.112	0.079
Population				1.000	0.999	0.966	0.998	0.605	0.976	0.999	0.999	0.983	0.114	0.023	0.354	0.257	0.517	0.239
Total Occupied Dwelling Units					1.000	0.969	0.999	0.617	0.977	0.998	0.999	0.985	0.103	0.023	0.357	0.262	0.516	0.258
Owner Occupied Dwelling Units						1.000	0.994	0.703	0.981	0.989	0.995	0.989	0.059	0.028	0.378	0.289	0.524	0.279
Total Automobiles							1.000	0.649	0.683	0.758	0.729	0.989	0.145	0.124	0.081	0.448	0.309	0.177
Automobiles per Capita								1.000	0.855	0.876	0.864	0.699	0.145	0.047	0.334	0.324	0.521	0.300
Automobiles per Family									1.000	0.976	0.977	0.756	0.159	0.027	0.327	0.309	0.514	0.281
Number of Employed Persons										1.000	0.998	0.964	0.122	0.016	0.345	0.264	0.498	0.256
Families											1.000	0.986	0.102	0.028	0.359	0.265	0.521	0.260
Populati n Density												1.000	0.309	0.467	0.133	0.477	0.320	0.192
Land Area of Recreation Area													1.000	0.097	0.156	0.493	0.055	0.090
Lake area														1.000	0.051	0.029	0.392	0.038
Overnight Cabin Area															1.000	0.335	0.647	0.187
Camping area																1.000	0.117	0.110
Scenic Trails																	1.000	0.044
Picnic Tables																		1.000

Table 8. 100 Mile Simple Correlation Matrix

	Total Trips	Trips per 1000 Persons	Trips per Family	Population	Total Occupied Dwelling Units	Owner Occupied Dwelling Units	Total Automobiles	Automobiles per Capita	Automobiles per Family	Number of Employed Persons	Families	Population Density	Land Area of Recreation Area	Lake Area	Overnight Cabin Area	Camping Area	Scenic Trails	Picnic Tables
Total Trips	1.000	0.689	0.678	0.229	0.226	0.206	0.042	0.221	0.042	0.144	0.169	0.332	0.015	0.047	0.855	0.454	0.496	0.216
Trips per 1000 Persons		1.000	0.989	0.485	0.484	0.464	0.483	0.403	0.030	0.453	0.468	0.082	0.028	0.198	0.457	0.581	0.058	0.063
Trips per Family			1.000	0.465	0.464	0.459	0.482	0.388	0.210	0.479	0.477	0.093	0.069	0.173	0.542	0.580	0.112	0.079
Population				1.000	0.999	0.983	0.631	0.947	0.653	0.963	0.999	0.677	0.114	0.023	0.354	0.257	0.517	0.239
Total Occupied Dwelling Units					1.000	0.989	0.625	0.957	0.653	0.963	0.999	0.708	0.103	0.023	0.357	0.262	0.516	0.258
Owner Occupied Dwelling Units						1.000	0.764	0.972	0.723	0.960	0.989	0.786	0.059	0.028	0.378	0.289	0.524	0.279
Total Automobiles							1.000	0.764	0.683	0.962	0.999	0.760	0.145	0.124	0.081	0.448	0.309	0.177
Automobiles per Capita								1.000	0.975	0.594	0.624	0.966	0.145	0.047	0.334	0.324	0.521	0.300
Automobiles per Family									1.000	0.963	0.962	0.969	0.159	0.027	0.327	0.309	0.514	0.281
Number of Employed Persons										1.000	0.983	0.720	0.122	0.016	0.245	0.264	0.498	0.256
Families											1.000	0.712	0.102	0.028	0.359	0.265	0.521	0.260
Population Density												1.000	0.177	0.018	0.401	0.269	0.594	0.292
Land Area of Recreation Area													1.000	0.097	0.156	0.493	0.055	0.090
Lake Area														1.000	0.051	0.029	0.392	0.038
Overnight Cabin Area															1.000	0.335	0.647	0.187
Camping Area																1.000	0.117	0.110
Scenic Trails																	1.000	0.044
Picnic Tables																		1.000

Table 9. 150 Mile Simple Correlation Matrix

	Total Trips	Trips per 1000 Persons	Trips per Family	Population	Total Occupied Dwelling Units	Owner Occupied Dwelling Units	Total Automobiles	Automobiles per Capita	Automobiles per Family	Number of Employed Persons	Families	Population Density	Land Area of Recreation Area	Lake Area	Overnight Cabin Area	Camping Area	Scenic Trails	Picnic Tables
Total Trips	1.000	0.769	0.748	0.113	0.123	0.136	0.134	0.350	0.227	0.212	0.225	0.311	0.015	0.047	0.855	0.454	0.496	0.216
Trips per 1000 Persons		1.000	0.999	0.439	0.421	0.391	0.365	0.182	0.402	0.481	0.434	0.215	0.028	0.198	0.457	0.581	0.058	0.063
Trips per Family			1.000	0.466	0.449	0.419	0.384	0.210	0.388	0.475	0.464	0.189	0.069	0.173	0.542	0.580	0.112	0.079
Population				1.000	0.999	0.989	0.751	0.670	0.954	0.998	0.999	0.324	0.114	0.023	0.354	0.257	0.517	0.239
Total Occupied Dwelling Units					1.000	0.994	0.734	0.861	0.962	0.998	0.999	0.364	0.103	0.023	0.357	0.262	0.516	0.258
Owner Occupied Dwelling Units						1.000	0.666	0.845	0.971	0.984	0.990	0.473	0.059	0.028	0.378	0.289	0.524	0.279
Total Automobiles							1.000	0.771	0.770	0.844	0.824	0.458	0.145	0.124	0.081	0.448	0.309	0.177
Automobiles per Capita								1.000	0.998	0.952	0.957	0.729	0.145	0.047	0.334	0.324	0.521	0.300
Automobiles per Family									1.000	0.959	0.962	0.941	0.159	0.027	0.327	0.309	0.514	0.281
Number of Employed Persons										1.000	0.998	0.403	0.122	0.016	0.345	0.264	0.498	0.256
Families											1.000	0.370	0.102	0.028	0.359	0.265	0.521	0.260
Population Density												1.000	0.003	0.108	0.482	0.262	0.666	0.365
Land Area of Recreation Area													1.000	0.097	0.156	0.493	0.055	0.090
Lake Area														1.000	0.051	0.029	0.392	0.038
Overnight Cabin Area															1.000	0.335	0.647	0.167
Camping Area																1.000	0.117	0.110
Scenic Trails																	1.000	0.044
Picnic Tables																		1.000

APPENDIX C

SAMPLE DATA

Table 10. Total Population Within Each Analysis Ring for Each Recreation Area

Recreation Area	Population 50-Mile Ring	Population 100-Mile Ring	Population 150-Mile Ring
Fort Mountain State Park	670,174	3,257,302	6,209,430
Georgia Veterans Memorial State Park	393,871	1,609,049	3,930,418
Red Top Mountain State Park	1,454,121	3,042,519	6,125,412
Franklin D. Roosevelt State Park	606,467	2,778,603	5,067,487
Ida Cason Calloway Gardens	621,907	3,113,040	5,526,988
Hard Labor Creek State Park	1,341,345	2,687,702	5,186,636
Laura S. Walker State Park	207,367	1,349,740	2,457,624
Vogel State Park	292,254	3,434,446	5,788,455
Kolomoki Mounds State Park	364,883	1,642,518	2,974,357
Jekyll Island State Park	588,057	1,161,523	2,109,871
Alexander H. Stephens State Park	340,807	2,947,787	5,363,316
Unicoi State Park	347,184	3,512,510	6,282,035
Indian Springs State Park	1,400,662	2,763,145	5,094,368
Little Ocmulgee State Park	322,406	1,205,397	4,323,452
Magnolia Springs State Park	442,465	1,748,285	3,950,247

Table 11. Total Occupied Dwelling Units Within Each Analysis Ring for Each Recreation Area

Recreation Area	Total Occupied Dwelling Units 50-Mile Ring	Total Occupied Dwelling Units 100-Mile Ring	Total Occupied Dwelling Units 150-Mile Ring
Fort Mountain State Park	189,524	913,150	1,738,792
Georgia Veterans Memorial State Park	102,527	419,254	1,059,088
Red Top Mountain State Park	411,174	847,620	1,689,579
Franklin D. Roosevelt State Park	160,255	755,887	1,384,161
Ida Cason Calloway Gardens	165,157	849,372	1,516,602
Hard Labor Creek State Park	374,699	743,145	1,422,764
Laura S. Walker State Park	54,703	368,757	657,576
Vogel State Park	78,243	965,012	1,601,370
Kolomoki Mounds State Park	95,852	432,258	789,490
Jekyll Island State Park	164,218	317,184	579,798
Alexander H. Stephens State Park	86,046	807,436	1,447,140
Unicoi State Park	94,284	986,858	1,728,735
Indian Springs State Park	391,582	756,329	1,387,821
Little Ocmulgee State Park	84,810	314,068	1,164,226
Magnolia Springs State Park	115,217	448,830	1,033,026

Table 12. Total Owner Occupied Dwelling Units Within Each Analysis Ring for Each Recreation Area

Recreation Area	Owner Occupied Dwelling Units 50-Mile Ring	Owner Occupied Dwelling Units 100-Mile Ring	Owner Occupied Dwelling Units 150-Mile Ring
Fort Mountain State Park	135,778	588,313	1,097,939
Georgia Veterans Memorial State Park	50,891	215,893	586,927
Red Top Mountain State Park	260,349	528,470	1,637,274
Franklin D. Roosevelt State Park	83,254	421,199	808,227
Ida Cason Calloway Gardens	86,234	476,839	887,571
Hard Labor Creek State Park	212,373	445,208	854,347
Laura S. Walker State Park	32,276	219,805	380,140
Vogel State Park	66,033	621,924	1,017,148
Kolomoki Mounds State Park	49,115	232,366	440,694
Jekyll Island State Park	107,410	194,334	345,936
Alexander H. Stephens State Park	44,977	464,772	854,265
Unicoi State Park	75,003	630,516	1,094,074
Indian Springs State Park	219,249	427,363	814,161
Little Ocmulgee State Park	45,964	163,678	651,796
Magnolia Springs State Park	61,326	247,587	593,273

Table 13. Total Automobiles Within Each Analysis Ring for Each Recreation Area

Recreation Area	Total Automobiles 50-Mile Ring	Total Automobiles 100-Mile Ring	Total Automobiles 150-Mile Ring
Fort Mountain State Park	118,434	618,678	747,688
Georgia Veterans Memorial State Park	99,675	370,073	896,273
Red Top Mountain State Park	505,612	683,299	855,907
Franklin D. Roosevelt State Park	133,702	673,753	955,687
Ida Cason Calloway Gardens	128,816	716,653	987,486
Hard Labor Creek State Park	446,525	766,979	897,919
Laura S. Walker State Park	58,752	213,942	390,011
Vogel State Park	52,259	604,332	798,642
Kolomoki Mounds State Park	51,343	195,317	396,929
Jekyll Island State Park	33,713	143,016	242,944
Alexander H. Stephens State Park	79,910	701,014	1,024,908
Unicoi State Park	84,518	618,687	818,341
Indian Springs State Park	460,802	823,839	1,055,035
Little Ocmulgee State Park	85,216	316,987	962,438
Magnolia Springs State Park	85,377	279,837	636,212

Table 14. Automobiles Per Capita Within Each Analaysis Ring for Each Recreation Area

Recreation Area	Automobiles Per Capita 50-Mile Ring	Automobiles Per Capita 100-Mile Ring	Automobiles Per Capita 150-Mile Ring
Fort Mountain State Park	0.340	0.344	0.294
Georgia Veterans Memorial State Park	0.253	0.270	0.301
Red Top Mountain State Park	0.345	0.335	0.321
Franklin D. Roosevelt State Park	0.295	0.321	0.311
Ida Cason Calloway Gardens	0.297	0.320	0.311
Hard Labor Creek State Park	0.333	0.319	0.312
Laura S. Walker State Park	0.283	0.281	0.271
Vogel State Park	0.317	0.344	0.326
Kolomoki Mounds State Park	0.248	0.267	0.279
Jekyll Island State Park	0.292	0.288	0.277
Alexander H. Stephens State Park	0.257	0.318	0.311
Unicoi State Park	0.320	0.342	0.325
Indian Springs State Park	0.329	0.317	0.309
Little Ocmulgee State Park	0.264	0.263	0.299
Magnolia Springs State Park	0.271	0.274	0.297

Table 15. Automobiles Per Family Within Each Analysis Ring for Each Recreation Area

Recreation Area	Automobiles Per Family 50-Mile Ring	Automobiles Per Family 100-Mile Ring	Automobiles Per Family 150-Mile Ring
Fort Mountain State Park	1.345	1.370	1.333
Georgia Veterans Memorial State Park	1.102	1.163	1.212
Red Top Mountain State Park	1.385	1.346	1.313
Franklin D. Roosevelt State Park	1.238	1.318	1.282
Ida Cason Calloway Gardens	1.243	1.314	1.281
Hard Labor Creek State Park	1.357	1.305	1.285
Laura S. Walker State Park	1.209	1.189	1.166
Vogel State Park	1.274	1.373	1.329
Kolomoki Mounds State Park	1.085	1.159	1.184
Jekyll Island State Park	1.265	1.216	1.180
Alexander H. Stephens State Park	1.158	1.315	1.287
Unicoi State Park	1.278	1.369	1.326
Indian Springs State Park	1.343	1.302	1.281
Little Ocmulgee State Park	1.127	1.142	1.257
Magnolia Springs State Park	1.196	1.182	1.246

Table 16. Total Employed Persons Within Each Analysis Ring for Each Recreation Area

Recreation Area	Number of Employed Persons 50-Mile Ring	Number of Employed Persons 100-Mile Ring	Number of Employed Persons 150-Mile Ring
Fort Mountain State Park	239,906	1,162,072	2,185,321
Georgia Veterans Memorial State Park	128,479	539,036	1,378,527
Red Top Mountain State Park	552,240	1,097,372	2,143,611
Franklin D. Roosevelt State Park	204,560	987,497	1,759,538
Ida Cason Calloway Gardens	211,441	1,100,422	1,924,136
Hard Labor Creek State Park	509,708	998,929	1,861,199
Laura S. Walker State Park	70,330	457,705	830,483
Vogel State Park	95,208	1,250,446	2,052,522
Kolomoki Mounds State Park	116,857	533,916	980,915
Jekyll Island State Park	203,186	387,556	696,901
Alexander H. Stephens State Park	114,848	1,091,178	1,902,328
Unicoi State Park	119,025	1,288,023	2,230,527
Indian Springs State Park	534,814	999,778	1,805,946
Little Ocmulgee State Park	108,575	405,452	1,503,328
Magnolia Springs State Park	144,926	575,465	1,354,841

Table 17. Total Number of Families Within Each Analysis Ring for Each Recreation Area

Recreation Area	Number of Families 50-Mile Ring	Number of Families 100-Mile Ring	Number of Families 150-Mile Ring
Fort Mountain State Park	171,000	819,306	1,552,012
Georgia Veterans Memorial State Park	90,427	371,792	935,392
Red Top Mountain State Park	364,996	759,770	1,513,129
Franklin D. Roosevelt State Park	144,247	670,640	1,231,890
Ida Cason Calloway Gardens	148,656	754,075	1,348,389
Hard Labor Creek State Park	328,956	661,004	1,271,513
Laura S. Walker State Park	48,594	321,632	572,036
Vogel State Park	71,925	863,581	1,438,829
Kolomoki Mounds State Park	85,430	382,270	700,899
Jekyll Island State Park	141,995	275,550	500,572
Alexander H. Stephens State Park	75,897	716,136	1,289,751
Unicoi State Park	86,448	882,073	1,554,090
Indian Springs State Park	343,022	671,975	1,237,981
Little Ocmulgee State Park	75,599	277,583	1,021,943
Magnolia Springs State Park	101,318	395,595	920,792

Table 18. Population Density Within Each Analysis Ring At Each Recreation Area

Recreation Area	Population Density 50-Mile (Person Per Sq. Mi.)	Population Density 100-Mile Ring (Person Per Sq. Mi.)	Population Density 150-Mile Ring (Person Per Sq. Mi.)
Fort Mountain State Park	62.66	129.81	101.76
Georgia Veterans Memorial State Park	42.46	50.48	64.77
Red Top Mountain State Park	170.87	100.44	88.61
Franklin D. Roosevelt State Park	66.99	105.77	72.11
Ida Cason Calloway Gardens	73.62	111.08	75.58
Hard Labor Creek State Park	138.47	85.64	73.97
Laura S. Walker State Park	24.39	39.85	44.81
Vogel State Park	38.78	126.30	102.80
Kolomoki Mounds State Park	39.16	51.56	52.00
Jekyll Island State Park	24.90	40.21	38.35
Alexander H. Stephens State Park	40.77	93.10	77.87
Unicoi State Park	48.57	114.12	97.22
Indian Springs State Park	153.70	88.78	73.46
Little Ocmulgee State Park	35.10	38.41	67.15
Magnolia Springs State Park	49.52	52.42	56.90

Table 19. Land Area of Each Recreation Area

Recreation Area	Land Area (Acres)
Fort Mountain State Park	2,514
Georgia Veterans Memorial State Park	1,300
Red Top Mountain State Park	1,246
Franklin D. Roosevelt State Park	5,003
Ida Cason Calloway Gardens	2,500
Hard Labor Creek State Park	5,804
Laura S. Walker State Park	306
Vogel State Park	222
Kolomoki Mounds State Park	1,283
Jekyll Island State Park	11,000
Alexander H. Stephens State Park	1,161
Unicoi State Park	278
Indian Springs State Park	510
Little Ocmulgee State Park	1,397
Magnolia Springs State Park	948

Table 20. Lake Area, Overnight Cabin Area, and Camping Area at Each Recreation Area

Recreation Area	Lake Area (Acres)	Overnight Cabin Area (Sq. Ft.)	Camping Area (Acres)
Fort Mountain State Park	17	920	50
Georgia Veterans Memorial State Park	7,000	8,280	0
Red Top Mountain State Park	12,187	6,830	28
Franklin D. Roosevelt State Park	15	10,120	0
Ida Cason Calloway Gardens	...	...	..
Hard Labor Creek State Park	237	2,588	55
Laura S. Walker State Park	160	0	9
Vogel State Park	21	29,924	6
Kolomoki Mounds State Park	88	0	10
Jekyll Island State Park	...	...	..
Alexander H. Stephens State Park	26	0	15
Unicoi State Park	50	8,000	4
Indian Springs State Park	105	2,608	12
Little Ocmulgee State Park	181	5,575	10
Magnolia Springs State Park	49	6,775	20

Table 21. Total Length of Scenic Trails and Total Number of Picnic Tables at Each Recreation Area

Recreation Area	Length of Scenic Trails (Miles)	Number of Picnic Tables
Fort Mountain State Park	1.0	50
Georgia Veterans Memorial State Park	0.5	55
Red Top Mountain State Park	1.5	109
Franklin D. Roosevelt State Park	1.0	65
Ida Cason Calloway Gardens	...	500
Hard Labor Creek State Park	0.5	72
Laura S. Walker State Park	0.0	50
Vogel State Park	1.5	20
Kolomoki Mounds State Park	0.5	100
Jekyll Island State Park	...	...
Alexander H. Stephens State Park	0.5	60
Unicoi State Park	0.5	53
Indian Springs State Park	0.6	120
Little Ocmulgee State Park	0.8	40
Magnolia Springs State Park	0.7	285

APPENDIX D

ADDITIONAL STATISTICAL INFORMATION

FOR EQUATIONS (1), (2), (3), AND (4)

Table 22. Trips Per 1000 Persons Related to the Total Population Within the 100-Mile Analysis Ring.

REGRESSION EQUATION: $Y_P = -0.000029X_{P2} + 158$

where Y_P = Total annual trip attractions per 1000 persons to a given recreation area.

X_{P2} = The total population within the 100-mile analysis ring for a given recreation area.

Observation	Calculated Trips Per 1000 Persons	Observed Trips Per 1000 Persons
1	63.25	29.19
2	111.12	186.80
3	69.50	41.94
4	124.24	218.17
5	77.18	116.96
6	67.45	112.72
7	110.02	68.56
8	118.76	63.76
9	79.53	41.02
10	55.82	44.27
11	58.09	138.60
12	107.16	78.69
13	72.26	14.52
14	122.96	87.54
15	77.63	72.54

Correlation Coefficient, R = 0.485
Coefficient of Determination R^2 = 0.234
Standard Error, $S(Y_P)$ = 54.33
Standard Error as Percentage of Mean = 62.0
F Ratio = 2.96

Statistical Data for Regression Coefficients

	100 Mile Population X_{P2}
Level of Significance	5%
t-test Value	1.72
Standard Error	0.000017

Table 23. Total Person Trip Attractions Related to Overnight Cabin Floor Space.

REGRESSION EQUATION: $Y_T = 13.58X_c + 89,756$

where Y_T = Total annual person trips attracted to a given recreation area.

X_c = The overnight cabin floor space in square feet at a given recreation area.

Observation	Calculated Total Person Trips	Observed Total Person Trips
1	102,252	95,084
2	202,220	300.570
3	182,525	127,596
4	227,212	325,000
5	89,756	112,620
6	89,756	86,067
7	124,908	110,655
8	198,417	155,509
9	496,201	475,998
10	181,778	137,568
11	89,756	42,811
12	165,479	105,528
13	125,179	200,432

Correlation Coefficient, R = 0.885
Coefficient of Determination, R^2 = 0.783
Standard Error, $S(Y_T)$ = 59,320
Standard Error as Percentage of Mean = 33.8

Statistical Data for Regression Coefficients

	Cabin Floor Space X_c
Level of Significance	5%
t-test Value	6.30
Standard Error	2.16

Table 24. Total Person Trip Attractions Related to Overnight Cabin Floor Space and Camping Area.

REGRESSION EQUATION: $Y_T = 12.67X_c - 1,229.26X_{cm} + 116.195$

where Y_T = Total annual person trips attracted to a given recreation area.

X_c = The overnight cabin floor space in square feet available at a given recreation area.

X_{cm} = The camping area in acres available at a given recreation area.

Observation	Calculated Total Person Trips	Observed Total Person Trips
1	66,388	95,084
2	221,101	300.570
3	168,311	127,596
4	244,135	325,000
5	103,902	112.620
6	105,132	86,067
7	81,375	110,655
8	212,636	155,509
9	487,951	475,998
10	177,448	137,568
11	97,756	42,811
12	174,537	105,528
13	134,487	200,432

Correlation Coefficient, $R = 0.900$
Coefficient of Determination, $R^2 = 0.811$
Standard Error, $S(Y_T) = 58,064$
Standard Error as Percentage of Mean = 33.2
F - Ratio = 21.42

Statistical Data for Regression Coefficients

	Cabin Floor Space X_c	Camping Area X_{cm}
Level of Significance	5%	5%
t-test Value	5.65	1.21
Standard Error	2.24	1,010,01
Partial Correlation Coefficient	0.873	0.359

Table 25. Total Person Trips Attractions Related to Overnight Cabin Floor Space and Total Population Within The 100-Mile Analysis Ring.

REGRESSION EQUATION: $Y_T = 13.49X_c + 0.013X_{P2} + 68,863$

where Y_T = Total annual person trips attracted to a given recreation area.

X_c = The overnight cabin floor space in square feet available at a given recreation area.

X_{P2} = The total population within the 100-mile analysis ring.

Observation	Calculated Total Person Trips	Observed Total Person Trips
1	104,287	95,084
2	198,138	300,520
3	187,109	127,596
4	232,309	325,000
5	78,204	112,620
6	78,606	86,067
7	134,477	110,655
8	199,962	155,509
9	495,223	475,998
10	173,344	137,568
11	96,988	42,811
12	159,515	105,528
13	187,275	200,432

Correlation Coefficient, R = 0.887
Coefficient of Determination, R^2 = 0.787
Standard Error, $S(Y_T)$ = 61,629
Standard Error as Percentage of Mean = 35.2
F - Ratio = 18.45

Statistical Data for Regression Coefficient

	Cabin Floor Space X_c	100-Mile Population X_{P2}
Level of Significance	5%	5%
t-test Value	6.00	0.437
Standard Error	2.25	0.029
Partial Correlation Coefficient	0.885	0.137

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